SPORT Aerobatics

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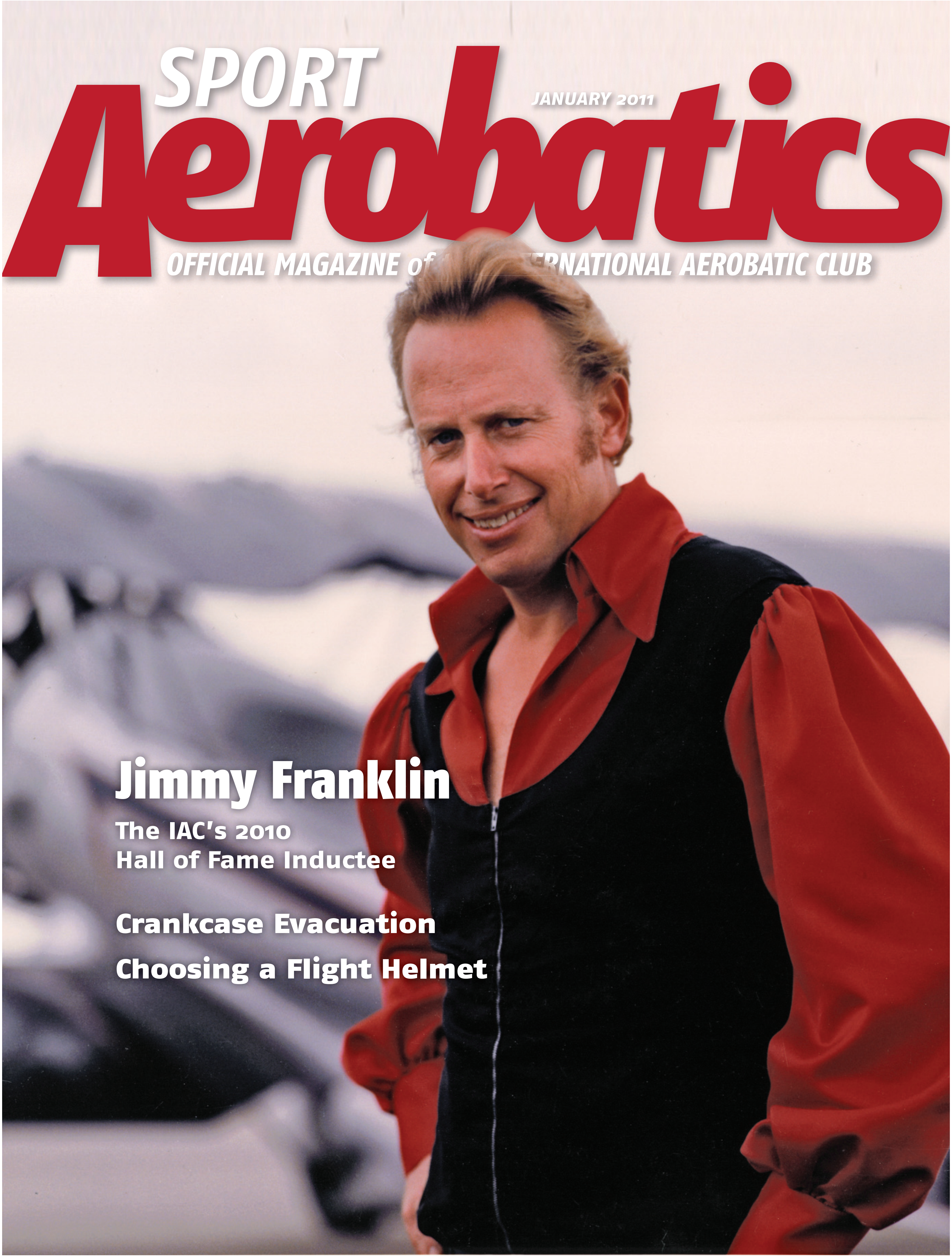

Jimmy Franklin

The IAC's 2010
Hall of Fame Inductee

Crankcase Evacuation

Choosing a Flight Helmet

SPORT Aerobatics
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Jimmy Franklin in his air show heyday.

PHOTOGRAPHY BY **DEKEVIN THORNTON**

SPORT Aerobatics
OFFICIAL MAGAZINE of the INTERNATIONAL AEROBATIC CLUB

PUBLISHER: Doug Bartlett
IAC MANAGER: Trish Deimer
EDITOR: Reggie Paulk
SENIOR ART DIRECTOR: Phil Norton
DIRECTOR OF PUBLICATIONS: Mary Jones
COPY EDITOR: Colleen Walsh

CONTRIBUTING AUTHORS:

Doug Bartlett
Kyle Franklin
Marshall Murray
Reggie Paulk
R.E. Van Patten
Allen Silver
Rick Volker

IAC CORRESPONDENCE
International Aerobatic Club, P.O. Box 3086
Oshkosh, WI 54903-3086
Tel: 920.426.6574 • **Fax:** 920.426.6579
E-mail: *reggie.paulk@gmail.com*

PUBLICATION ADVERTISING

MANAGER, DOMESTIC:
Sue Anderson
Tel: 920-426-6127
Fax: 920-426-4828

MANAGER, EUROPEAN/ASIAN:
Willi Tacke
Tel: +498841/487515
Fax: +498841/496012
E-mail: *willi@flying-pages.com*

COORDINATOR, CLASSIFIED:
Alicia Canziani
E-mail: *classads@eaa.org*

MAILING: Change of address, lost or damaged magazines, back issues.
EAA-IAC Membership Services
Tel: 800.843.3612 **Fax:** 920.426.6761
E-mail: *membership@eaa.org*

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DOUG BARTLETT
COMMENTARY / **PRESIDENT'S PAGE**

Enclosed is a Q&A I had with Ryan Birr of the Northwest Insurance Group, our aerobatic insurance partners.

Doug: I have a series of questions for Northwest Insurance Group (NWIG) that may help our members understand what is taking place with our IAC / NWIG insurance agreement. The end of our three-year agreement comes up for renewal on April 1, 2011. I understand Berkley will not provide aerobatic insurance policies after December 1, 2010. Is that correct?

Ryan: That is correct.

Doug: Were they required to provide us insurance policies until the end of our agreement?

Ryan: No, the agreement for services was directly with NWIG and not with Berkley, they are under no obligation to provide the product. They did, however, agree to carry the program through December 1, 2010, as a courtesy to us and the IAC.

Doug: Will NWIG be able to provide IAC members with competitive aerobatic policies?

Ryan: We have been working hard to find homes for members that won't have Berkley as an option on renewal. Since we have the entire aviation market (except AVEMCO) to work with, we have been relatively successful finding IAC members an insurance product to meet their needs at a competitive price. The coverage forms are vastly different from one company to the next, so our job has really been to make sure coverages are in place for the type of flying that each insured is involved in. We are more than happy to continue to provide our brokerage services and insurance counsel to IAC members. We'll have to look at the services contract to determine the best way to move forward, since we won't have an exclusive product from 12/01 forward, which our contract with IAC requires.

Doug: Why did Vicki Cruse approach NWIG to establish an insurance program?

Ryan: Vicki approached us to bid on the then-expiring contract with the previous program provider. She conducted a member survey that

Please submit news, comments, articles, or suggestions to: *reggie.paulk@gmail.com* showed 1) the members were unhappy with the service from the brokerage and 2) that the product wasn't doing everything that the IAC wanted from its insurance program. She was looking for a program that would be nondiscriminatory towards the various aircraft that were involved in IAC competition, which would provide a host of additional coverages in addition to basic hull and liability (member benefits), which would also provide coverage when aircraft went to foreign countries for competition, and, finally, would provide a reasonable revenue stream back to IAC. She was also looking for an exceptional level of service to the membership from the provider.

Doug: Why did Berkley pull out of providing the IAC with aerobatic insurance policies?

Ryan: I can only speculate on the real reason but 1) the cost of the program (losses versus premium) was clearly too high. The participation in the program by the IAC membership was lukewarm considering our 3 years of involvement with the Club and the massive amount of promotion we did. So, the combination of low premium volume and policy count combined with high claims expense in the end necessarily warranted Berkley's exit simply on an economic basis. Insurance companies work for a profit and we had three years to deliver profits to Berkley…it didn't work out so well.

Doug: Did Berkley provide IAC members with a superior product at a fair price?

Ryan: NWIG was able to negotiate an exceptionally comprehensive policy form, low pricing, worldwide territory, lots of coverages, and significant financial support. The key here was that it was a "true program" with pooled underwriting; if claims expense was high then premiums would increase. If they were low, premiums would decrease. The program would take all IAC aircraft, nearly all pilots, in all conditions, and cover them anywhere in the world.

Since the "program" is now concluded, we are forced into market pricing.

Doug: Why was there a large swing in the cost of insurance policies over the last three years?

Ryan: Claims and program expenses exceeded initial estimates. We did not get the participation that Vicki originally thought we would, and the claims grew to unacceptable proportions. The pricing simply followed claims experience. Premiums went up three separate times due to claims experience in the program. Additionally during the past year, as members started to leave for lower pricing, then the program's profitability quickly eroded, creating a spiral effect. This is not an unusual phenomenon with insurance programs though; some programs do survive if participation is garnered soon enough in the program's infancy.

Doug: Can we receive a similar product from other insurance providers at a competitive price?

Ryan: Since the "program" is now concluded, we are forced into market pricing. In other words, the pricing that members receive is now what is available in the open marketplace and no program pricing is available.

Doug: Is there any reason the IAC should work directly with insurance agencies to provide insurance options for its members?

Ryan: That depends on whether or not you can convince an insurance brokerage to pay royalties and extensive advertising costs. If we have a dedicated program or we otherwise just market the accounts, we still provide a substantial service to the IAC members regarding coverages for their activities, whether it's for practice, for competition, for sightseeing, or dual instruction, or for air shows. But we can do that independent of the IAC contract, in which case the IAC loses all its revenue for our services. IAC needs to decide how much it is willing to promote this service (we or others provide) as a member benefit in order to generate revenue for the Club. We do know that we have given a substantial amount of financial support to the IAC as part of this contract during the past 3 years. I can't imagine why the IAC wouldn't want a brokerage involved in some capacity in order to continue receiving financial benefits from such a service, even if it's not NWIG.

If anybody has any questions or would like to discuss this issue further, I can be reached by email at *doug.bartlett79@gmail.com* or by phone 847-875-3339. Fly safe and keep plenty of altitude below you! IAC

Max Immelmann and his dog (note "the Blue Max" just below Max's collar).

Immelmann

Whose turn is it?

by R.E. Van Patten, Ph.D.

Max Immelmann was one of the first German fighter aces of World War I. He began pilot training in November 1914. Initially assigned to liaison flights servicing German aerodromes, he soon moved on to recon missions. He was shot down for the first time in June 1915 and landed within his own lines without injury. Shortly thereafter Fokker's new monoplane, the Eindecker E1, was introduced. It was equipped with a mechanism to synchronize the machine gun with the engine to permit firing through the arc of the propeller.Max and his squadron mate Oswald Boelcke started the "Fokker Scourge" flying this aircraft.

Scoring against a British B.E.2c bomber on August 1, 1915, Max earned the Iron Cross first class; he stalked his victim all the way to the ground, landed, shook hands with the pilot, and took him prisoner. He scored more kills in September and survived being shot down by a French farmer. By early December, Max had run his score up to eight and was being acclaimed as Der Adler von Lille (The Eagle of Lille); Max liked patrolling over the town of Lille. After both Max and Oswald had scored their eighth victories, they were awarded the ultimate decoration of Imperial Germany, the Pour Le Mérite, following which it was dubbed "the Blue Max."

The name "Max Immelmann" has long been associated with a maneuver called the Immelmann turn. The modern aerobatic competition Immelmann turn consists of a half-loop from level flight and a half-roll to upright at the top of the loop, with a consequent 180-degree reversal in the direction of flight.

What is now known as the Immelmann turn would probably have resulted in a fatal accident if attempted in the planes Max flew.

The Fokker monoplane in 1915 still used wing warping for roll control, and those who flew it and survived described its handling and stability as "tricky." In a personal communication [1], author Mike Hawkins described the shortcomings of wing warping as a means of roll control and commented, "With the Fokker, the aircraft would be at or below stall speed at the top of the half-loop, and application of wing warp to roll out would result in unpredictable direction and rate of roll, most probably leading to a spin! Recovery from a spin was not understood in 1915, and it is most unlikely the pilot would have survived."

A controversy continues over who actually invented this style of fighting, since Max stated, "I do not employ tricks when I attack." Nothing in his letters or memoirs indicates that he originated the half-loop, half-roll maneuver now named after him.

At least one source has suggested that Allied pilots later used the modern version of this maneuver to escape

Max Immelmann—"the Hun in the sun"—in the initial high-side dive portion of his attacking style

from Max [3]. Given a target equipped with aileron roll control and with sufficient energy to do it, a half-loop, half-roll maneuver would have been an excellent tactic for defeating Max's preferred repeated diving/zooming/hammerhead stall style of attack and would certainly have left Max out of airspeed and options.

The style of attack Immelmann used was the first application of vertical maneuver in air combat, and he deserves his place in history for that innovation [5] [4]. Although initially shocking to Allied pilots, it soon came into common use on both sides in World War I. However, as more powerful engines became available, it lost much of its initial advantage, since at the top of the zoom in a hammerhead stall the attacker provided an almost motionless target with only one energy option.

Max died in air combat with a two-seat Royal Aircraft Factory F.E.2b on June 18, 1916. Accounts of his death vary. In his account [2], Franz Immelmann (Max's brother) describes what reads like a serious structural failure in the section of the fuselage aft of the cockpit, with a portion of the airframe lashing back and forth. This might have been damage inflicted by machine-gun fire from the British plane. He also reports that it's probable the engine mount had also failed, owing to the destruction of the propeller and the resulting high unbalanced loads. This had happened to Max at least once previously with a synchronizer failure. Franz Immelmann [2] verified that an examination of the wreckage of his plane revealed a failure of the gun synchronizer gear, since his propeller was shot to pieces exactly in line with his own guns [3]. Ironically the technology that made him an ace also probably killed him.

A fitting posthumous tribute to Max developed during the Vietnam War. The U.S. Air Force Tactical Air Command issued an order to disable the rudder limiter on the F-5. When in flight, with the gear up, this limiter restricted the F-5 rudder to 6 degrees of deflection. With the gear down, this limiter was changed to permit 30 degrees of deflection. The modification to the hydraulic system and controls was subsequently carried out, and the F-5 suddenly became the most maneuverable fighter in the air. Pilots very quickly started exploiting the same maneuver that Max used—but with a difference. In a head-on merge, for example, it was used to avoid falling into the sustained "knife fight in a telephone booth" of the rolling scissors scenario. By using this vertical maneuver at the merge to "out-turn" the adversary, an immediate position for a stern attack was gained. This maneuver is now called the "high yo-yo" and is probably one of the first maneuvers taught to the novice fighter pilot [6]. IAC

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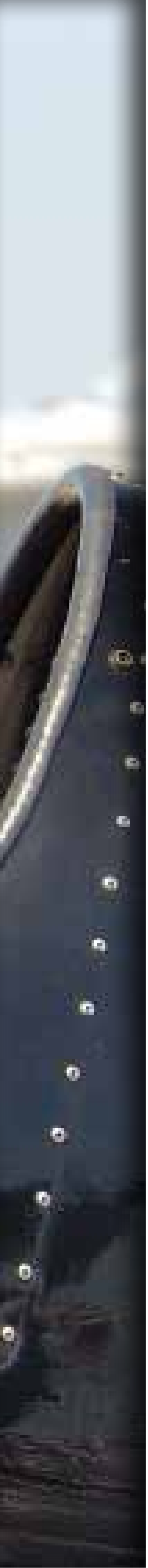
Jimmy Franklin



Jimmy Franklin
IAC's 2010 Hall of Fame inductee

BY KYLE FRANKLIN WITH REGGIE PAULK

THE ATTENTION OF THE SPECTATORS is drawn to a thin ribbon of smoke trailing down from the blue sky; the deafening roar of a 450-hp Pratt & Whitney radial engine on a large black and silver biplane comes over the threshold. Rolling inverted, the pilot allows the vertical fin to sink to within 4 feet of the runway. At 185 miles per hour, he picks up a ribbon being held by two men and streaks past show center, still in the inverted position, the ribbon streaming from the tail. This was Jimmy Franklin.

Few men can write their own destiny. Jimmy Franklin happened to be one of a rare breed. Born in 1948, he was raised on a ranch near Lovington, New Mexico. Jimmy started learning to fly while still in diapers, sitting on his father's lap as they flew 30 miles between their farm and ranch. When he was 8 years old, Jimmy was capable of flying. At age 12, he snuck out and soloed himself while home alone. That same year, after viewing his first air show, he began teaching himself aerobatics from a book. Flying aerobatics over the next seven years laid the foundation and development of a man far beyond his years. In 1967, at age 19, Jimmy bought a stock 1940 Waco UPF-7 and began performing air shows in it that same year.

Over the next 38 years, Jimmy and his Waco would thrill audiences all over the world. He performed in Canada, Mexico, Japan, and even Australia. Jimmy's artistry can also be seen on the silver screen and countless television shows, such as *Terminal Velocity*, *Forever Young*, *The Rocketeer*, *Three Amigos*, and *Choke Canyon*.

At age 12, he snuck out and soloed himself while home alone.

DEKEVIN THORNTON

During this time, Jimmy introduced more than 20 unique air show acts in 10 different aircraft. A few of these acts included a routine with Eliot Cross named "The Dueling Wacos," with dual wing-walking routines and comedy acts. Jimmy created a character called "ZAR," in which he portrayed a comic book/space age character flying a black and silver, twin-engine Aerostar, the Starship Pride.

Always a true showman, Jimmy was recognized and honored many times during his years as an air show professional. He received the coveted Bill Barber Award for Showmanship in 1989; the Clifford W. Henderson Achievement Award in 1999; the General Aviation News and Flyer Reader's Choice Award for favorite overall performer and favorite specialty act in 1990 and 1996; and the ICAS Foundation Air Show Hall of Fame in 2007. Jimmy was the first person to receive the Art Scholl Showmanship Award in 1986 for his ZAR act. He received the award a second time in 1999 for his showmanship in his Jet-Waco, making him the first and only person to receive the Art Scholl Showmanship Award twice. In 1999, Jimmy debuted his crowning achievement: the world's first and only jet-powered Waco.

With the help of Les Shockley, creator of the "Shock Wave" jet truck, they were able to mate a CJ610 (J-85) jet engine along with the 450-hp Pratt & Whitney radial engine to Jimmy's Waco biplane. With an air show weight of 3,200 pounds and both engines turning, the Jet Waco put out more than 4,500 pounds of thrust and more than 2,000 hp, giving a vertical climb rate of more than 10,000 feet per minute. In Jimmy's hands, this 1940 Waco was able to perform stunts no one has ever seen or even attempted in this type of plane. He added a wing-walking act with his son Kyle, who became the world's first jet wing walker.

In 2002 Jimmy, his Jet-Waco, and a few of his closest air show friends redefined the term "air show" by forming the infamous X-Team, which gave birth to the "Masters of Disaster" or M.O.D. Their act quickly became the wildest and most talked about air show act in the aviation community.

Tragically, Jimmy and longtime friend Bobby Younkin were both lost while performing the Masters of Disaster, at a show in Canada in 2005. Jimmy was 57 years old.

During his lifelong aviation career, Jimmy would reinvent and change air show entertainment over and over again while amazing and inspiring thousands of people young and old. He was known to say, "When I was 12 years old I decided I was going to become an air show pilot, and here I am this many years later still trying to become one."

There is no doubt Jimmy Franklin left his mark on the aviation world. Anyone who saw him fly would be hard-pressed to forget his performances for their constant pushing of the limits of both airplane and pilot. To get a better look inside the life of Jimmy Franklin, you have to talk to his son and air show colleague, Kyle Franklin.


DEKEVIN THORNTON

In 1999, Jimmy debuted his crowning achievement: the world's first and only jet-powered Waco.

Accepting the Hall of Fame Award on his father's behalf, 30-year-old Kyle Franklin is himself an accomplished aviator. When Kyle lost his father in 2005, he was only 25 years old, but he'd already spent seven years performing wing walking and air show acts with his dad. When Kyle was born in 1980, his father had already been flying air shows for 23 years. His is a unique perspective of a man whose lifeblood was the air show season.

"My dad flew air shows for over 38 years, and I naturally grew up around air shows and airplanes," says Kyle. I knew from a very young age my father was one of the better air show pilots out there. He was good at what he did, and I was always proud of everything he'd done."

In the 38 years he performed air shows, Jimmy created more than 20 unique acts. For one of the acts, he created a space-age comic character dubbed ZAR. Flying a twin-engine Piper Aerostar, Jimmy would dress in a black costume complete with helmet and cape. At the time, 4-year-old Kyle was instrumental in the character's design. "He used me as his test subject," says Kyle. "He was gearing the act toward children, and it was the whole Star Wars era in the early '80s. He would try out different costumes and ideas to see what his 4-year-old son thought."

At the time the ZAR act was created, no one had ever seen anything like it. "The kids and adults alike ate the act up," Kyle remembers. "Whenever he'd come out in that black outfit with the helmet on and the whole back story, you couldn't hardly pull him away from the crowd. It was an amazing act flyingwise, with all the showmanship involved. It was still going strong when Dad retired it in 1991." Jimmy and Kyle discussed bringing the act back many times in the intervening years, and Kyle says he's young enough that it could come back someday.

Jimmy Franklin considered the '80s to be the heyday of the air show business. During that time, he was crisscrossing the country—flying three to four different airplanes at 35-40 shows a year. "He had the Waco Mystery Ship and the Waco 600," Kyle says. "He had the Aerostar for ZAR and the Super Cub for a motorcycle transfer and comedy act."

When Kyle started school in 1985, he and his mom weren't able to travel to air shows with Jimmy. Kyle went to school and attended what air shows he could. When he turned 12, he decided to begin traveling with his dad every summer. "I would typically finish up my last final at school," he says. "And then, the next day, catch an airline out to whatever part of the country he was out air showing. I did that from the time I was 12 years old pretty much until I graduated from high school."

Jimmy taught Kyle to fly in much the same tradition that he'd learned himself. "He taught me just about everything I know now," Kyle continues. "All of the things I do in my comedy routine are things I learned to do in the Super Cub with my

JIM KOEPNICK

For 38 years, Jimmy Franklin thrilled crowds at air shows.

Kyle and Amanda during an air show performance. DEKEVIN THORNTON

dad. He focused a lot on ground control, knowing the airplane, not being afraid of it. I learned that at 9 years old."

Kyle first practiced wing walking when he was 14 years old. "I got bored at a show," he says. "I'd been bugging him for a while to do some wing walking, and I'd been practicing a lot on the ground. We went up the Friday before a show; I crawled out of the front cockpit, climbed up on top, and stood on the top wing."

Three years later, Kyle was 17 years old and finishing up his last years of high school. The wing walker Jimmy was working with at the time quit at the beginning of the season, and there weren't any alternates. Kyle suggested he wing walk for the season until they could find someone else. "He wasn't really keen on that idea," he says. "He had to think about it for a couple of weeks. We sat down and discussed all of the risks involved, and eventually, I did my first professional wing-walking show."

Since Kyle was still in school, he would take a half-day off on Friday, hop on an airliner to wherever his father was flying, spend the weekend wing walking, and then jet back home Sunday evening so he could go to school on Monday morning. "It definitely beat working at the local fast-food joint," he says.

Jimmy was known for pushing the envelope, and it earned him the dubious distinction of being the only air show performer to get red-flared at Oshkosh. In 1975, many air show aircraft were not equipped with radios, so the air boss would shoot a red flare if he saw something he thought to be unsafe. In no uncertain terms, the flare meant to get your butt back on the ground immediately. This was Jimmy's debut at Oshkosh, and the 27-year-old pilot made a decision that cost him a couple seasons of air showing.

"He was taxiing to takeoff," says Kyle. "Someone comes running out and tells him they don't want him to do his ribbon pickup. They'd briefed it and everything was okay, so he asked why not. The person said they didn't know; they just didn't want him to do the ribbon pickup. My dad had two people hold a ribbon about 6 feet above the ground. He would fly inverted and pick it up with his tail. It kind of pissed him off, so he went out there and beat the ground really good and did an aggressive routine. At Oshkosh, there's a little ravine between the runway and the taxiway. On his last pass, he rolled upside down and sank into that ravine, and more than half the tail disappeared. He had a 4-foot wire on the rudder to catch the ribbon, and when he pushed out, he ended up with grass on the wire. They shot the flare, and that stunt wound up costing him three years in the air show business more or less. In 1975, he had his biggest season, with 18 shows. He did six the next year. I still have footage of that flight on his tribute DVD."

In the end, the air show business is all about thrilling the crowd. "We're always trying to get your attention—get your adrenaline going," Kyle says. "Most of the time, it's smoke and mirrors and illusion trying to get that thrill out of you."

For 38 years, Jimmy Franklin thrilled crowds at air shows. The precious little time he did get during the off-season was spent preparing the airplanes and creating new acts. He did engage in a few hobbies, however. "He liked old Western stuff," remembers Kyle. "He had a huge collection of old Aladdin lamps. He also liked Winchester rifles and Colt revolvers. I still have most of his collection of lamps because I think they're pretty neat as well."

When Jimmy Franklin was 12 years old, he saw Harold Krier and Charlie Hillard perform at his first air show. "It was a defining moment for my father," says Kyle. "After he watched that air show, he started getting airplane magazines. He was thumbing through an antique airplane magazine, and on the centerfold that particular month was a Waco UPF-7. He thought it was the coolest airplane he'd ever seen, so he pulled the center section and hung it on his wall. His mom eventually had it framed and put it back up. When he was 19, he and his father had gone to an air show as spectators. As they were leaving the show, Jimmy noticed an airplane that looked kind of familiar. It was a Waco UPF-7. It turns out, it was the exact same airplane he'd hung on his wall: N2369Q. They bought it on the spot for $4,500 dollars. Jimmy flew it home, started practicing with it, and flew his first air show that year. Over the years, the airplane changed and had other parts put in it. It would eventually become the Jet-Waco and was the airplane he was in the day of his final flight. He was destined to find that airplane and do what he did. What are the chances of finding the airplane you fell in love with at 12 years old, had hanging on your wall, and then use it in your air show career?" IAC

Exhaust-Driven Crankcase Evacuation Systems

An extremely reliable process

by Marshall Murray, Sky Dynamics Corporation

Photos courtesy Sky Dynamics

Using exhaust flow to extract engine crankcase pressure has significant positive effects in piston aircraft applications. These benefits range from engine efficiency improvements to the general maintenance improvement of reducing oil leaks and the ever-important aesthetic improvement of keeping the breather oil from soiling the belly of the airplane. Over the last 30 years of exhaust system development at Sky Dynamics, we've advanced the interaction of the crankcase evacuation system into our collector-style exhaust systems to the point that it's now standard on all exhaust applications—whether it's a custom lightweight system for Sean Tucker's new plane or a production Cub Crafters light-sport aircraft system. Through in-house testing and our history of working with the top aerobatic and race pilots, we've been able to evolve the design details and the manufacturing process to make the system extremely reliable. Along the way, we've also found the system to possess other unique benefits.

The success behind our crankcase evacuation system is that removing the positive crankcase pressure which builds up due to normal combustion leaks causes the engine to operate more efficiently. This efficiency increase manifests itself as a lower fuel burn, an increase in ultimate power, and an increase in longevity. The increase in efficiency is derived from the many positive effects of the depression that is created inside the crankcase. The first positive effect is the reduction of pumping resistance felt by the piston. Considering the relatively large surface area on the underside of a typical aircraft piston due to the large bore diameter, this benefit alone proves substantial. The crankcase vacuum also increases the pressure differential that helps to maintain a piston ring seal. This not only increases combustion efficiency but also reduces the amount of engine

PHOTOGRAPHY BY **DA-KUK@ISTOCKPHOTO.COM**

Experimenting with collector length and position on Sergey Rakhmanin's RBAR plane.

oil that finds its way into the combustion chamber. Oil in the combustion chamber can reduce the detonation threshold, which is extremely important to max-effort applications but is also becoming increasingly vital to all piston engine applications as we face the imminent demise of 100 low lead.

The crankcase evacuation system works due to a concept that we're all familiar with—–the speed-pressure relationship of a fluid, defined by Bernoulli's principle. As Bernoulli's principle can be adapted into many specific fluid flow situations, including situations that approach high Mach numbers, the principle applies here in two ways. The first takes advantage of the Venturi effect through a low-pressure area designed into the exhaust system. This is similar to the basic function of a carburetor as the tapered throat area causes a reduction in pressure that draws fuel into the airstream. The second application of the principle is that the exhaust flow across the evacuation tube's open end further aids in reducing the pressure within the evacuation section. The most commonly known example of this dynamic pressure situation is the lift of an airplane wing, where a low-pressure area is formed due to higher-velocity airflow across the top of the wing. This airflow can be compared to the exhaust flow surrounding the evacuation tube.

Bruce Bohannon's record breaking turbocharger system.

CP Elliott (SD A&P) installing lightweight 6/1 exhaust with evacuation on Mike Goulian's RBAR plane.

While this type of crankcase evacuation system is beneficial to all piston engines, it lends itself particularly well to high-performance aircraft applications due to the allowable design requirements. As the typical noise constraints of performance aircraft are relatively loose, the exhaust system isn't limited in ways that standard category aircraft exhaust systems are. This means that the exhaust system can be built so that there's no compromise in performance.

You can also find different types of crankcase evacuation systems in other performance applications. Some owners of automotive breather systems attempt to employ crankcase evacuation with a misplaced suction tube inserted into the side of the exhaust stream. Then, because the fitment is rarely ideal, they're forced to put a check valve in the line so that exhaust backflow can't find its way into the crankcase. A problem appears when exhaust pressure forces the check valve to close. The crankcase has no breather and quickly builds pressure—–exactly what we're trying to avoid. Another form of crankcase evacuation is found in high-end racing vehicles. These vehicles use a dry-sump oiling system which, in scavenging oil from the sump, creates a negative crankcase pressure to produce many of the same benefits that we get from exhaust-driven crankcase evacuation. Some may also be familiar with dry-

Closeup of crankcase breather fitting on Sean Tucker's exhaust system

Bruce Bohannon Exxon Flyin' Tiger installation


Crankcase evacuation line pictured (center of the collector).

sump systems in aviation if they've had to deal with the older Lycoming AIO engines. Thankfully, further development led Lycoming to release the updated AEIO engines that addressed inverted flight situations in a more reliable manner.

Over the years, Sky Dynamics has been privileged to work with the most innovative pilots, teams, and manufacturers in the industry. Most recently we've built close relationships with several of the Red Bull Air Race (RBAR) teams. Since we supplied parts to each of the teams, we were in an enviable and unique position as one of the very few companies who could walk from hangar to hangar in the Red Bull pits and discuss in detail each team's aircraft. One team was especially receptive to testing, and therefore very important to recent developments. The Spanish RBAR team of Alejandro (Alex) Maclean and technician Jesus Canadilla were continually willing to perform testing that contributed to our 6/1 lightweight collector development. During one of the initial tests of the race exhaust's crankcase extraction system, we were using our normal 24-inch liquid manometer for depression measurement. As the throttle was opened on a ground run-up, the evacuation system created such a negative pressure that the manometer fluid was almost sucked into the engine before power could be reduced. Soon after, we switched to a handheld electronic manometer for testing.

Second and more importantly, when troubleshooting a technical issue, preconceived notions will often delay finding the solution.

We had another memorable learning experience in the ongoing development of our evacuation system a few years ago when Bruce Bohannon was setting records with his *Exxon Flyin' Tiger* RV-4. We manufactured the turbocharger system that was necessary for his record time-to-climb run up to 12,000 meters. Because we had such success with implementing the crankcase evacuation in our normally aspirated exhaust systems, we fitted a similar system into the turbine discharge tube of his exhaust. We selected a location that seemed comparable to the chosen point in our standard systems. Unfortunately, Bruce found that at certain manifold pressure/rpm settings, oil temperatures skyrocketed! As these things always go, the airplane had been finished up only days before the record flights with little time for comprehensive testing. Increasing the stress of resolving the issue quickly was that it all took place as an attraction at the Sun 'n Fun Fly-In at Lakeland, Florida. In hindsight, one of our first thoughts was the crankcase evacuation backflowing into the breather section of the rear accessory case and erroneously increasing the oil temperature reading. However, our design was so well thought-out, that couldn't be the problem! But in fact it was. The turbulence of the mediocre exhaust stream wasn't acting on the extraction point as it does inside our collectors which are optimized for smooth, consistent flow. This situation clearly demonstrated two things. First, the implementation of the crankcase breather requires thorough testing for each individual application. Second and more importantly, when troubleshooting a technical issue, preconceived notions will often delay finding the solution. After a day of troubleshooting, we corrected the problem; Bruce flew the flight on schedule and from there continued on to an ultimate ceiling record beyond 47,000 feet.

Being able to work with these pilots in real-world applications is the ultimate form of data gathering, though it would be impossible to obtain all of the necessary information from this method alone. For in-house testing we have an engine dynamometer cell that allows us to experiment in a controlled environment. Using our dyno cell, we're able to datalog all of the pertinent values that we're looking for as well as simulate atmospheric conditions such as increased manifold conditions due to ram air in flight. The dyno enables us to quickly, and more importantly safely, try new combinations. From that, we've been able to fine-tune the crankcase scavenging.

During testing, we're able to measure pressures in multiple locations. The two most beneficial areas for data analysis are inside the breather line near the extraction point as well as the interior of the crankcase. These measured values are plotted along with the dyno cell ambient pressure as a reference. Our dyno software incorporates linear-signal pressure sensors (similar to the ones used with the high-end engine analyzers) and has a sample rate that is configurable to beyond 100 times/second. With this data we can easily find the best location for the breather tube in reference to the exhaust collector shape and engine application. We can also quickly perform back-to-back testing with the crankcase evacuation line connected versus disconnected.

On a tight six-cylinder engine with a standard breather setup, we'll normally see a rise of approximately 0.5 inHg of pressure inside the crankcase by 2,700 rpm, though it's rising at an increasing rate as we push the engine through 3000 rpm. Whereas on a high-time six-cylinder engine at 2700 rpm, a pressure reading of 1 to 2 inHg is common. Considering the area inside the crankcase, that alone


Complete Harmon Rocket tight-cowl system.


Installation shot of Sean Tucker's plane.

can mean substantial force pushing the case apart. But in reality, that force is relatively miniscule compared to the many thousands of pounds exerted by cylinder combustion. It's not surprising then that case-split oil leaks and broken cylinder base studs are common problems. In contrast to a standard breather setup, with a proper evacuation system fitted we typically see a crankcase depression of at least 1 inHg by 1500 rpm, increasing to 3 inHg of negative pressure at 2700 rpm.

In addition to our engine dyno, we also have a thrust test stand with which we're able to accurately measure the force of an aircraft's thrust in a safe manner on the ground. (Think automotive chassis dyno but with a bit more wind.) We can also plot thrust versus rpm and even 3D maps that can reference lambda, exhaust gas temperature, crankcase pressures, etc. One of the recent test planes was Red Bull pilot Sergey Rakhmanin's MXS-R. We took the time to measure the thrust produced over a variety of modifications, but as is notable here, we were able to measure the thrust difference with and without the crankcase evacuation system hooked up. Because of the convenience of this testing method, we were able to repeatedly test with and without evacuation in a short period of time. Each time we unhooked the crankcase evacuation line from the exhaust system, the plane lost 8 to 9 pounds of thrust. In a series where the teams were looking for 1 pound of thrust from an engine or prop mod, 9 pounds was a great number to see and really made our time spent in development worthwhile. With all of the modifications made over the course of a busy three days between races, the aircraft had gained more than 100 pounds of thrust when technician Antanas Marciukaitis flew the plane out.

Although the crankcase evacuation system was created for the benefits mentioned earlier, we've found other advantages to the system. In practice, the air/oil mixture that manifests itself as oil dripping from a standard breather line outlet is now being burned in the exhaust stream. As such, some will notice a light puff of smoke from the exhaust after certain maneuvers. This is caused by oil building up in the inverted system's separator can, which is then drawn out through the exhaust. The same oil loss goes unnoticed in standard applications——it gets dumped overboard via the breather line. And because the oil turns to smoke inside the collector when the plane is under power, the crankcase vapors no longer leave their stain on the belly of the fuselage. When flying long vertical uplines in an application with a breather that extends back to the tail, the line can become clogged, which effectively closes off the engine's ability to breathe.

There are other, more exciting benefits as well. The vacuum signal is a direct result of flow through the engine. This can be translated a few different ways. Total engine power can be deduced from the vacuum reading as a relative number that can be referenced throughout a series of engine modifications. Keep in mind, though, that altering lambda by switching to a lower-energy fuel such as ethanol would greatly increase the mass flow through the exhaust and would need to be accounted for, just as an overly rich gasoline mixture would. Similarly, as the vacuum signal can be treated as a direct measurement of mass flow through the engine, it's ideal for use as a fuel delivery reference value. Because this method would pose no additional restriction to engine airflow like a Bendix RSA does by its incoming air measurement, we're looking into integration of this method for the power enrichment section of our new fuel servo.

Additionally, there are more pedestrian uses of the crankcase evacuation. The amount of depression created by the evacuation tube has proved to be an excellent indicator of engine health. Making note of vacuum readings at specific rpm points in the engine log on a regular basis can show if a piston ring seal is beginning to deteriorate. Also, the suction line can be used as an emergency backup source for vacuum-driven instruments in the event of a vacuum pump failure.

After considering all the advantages of using a low-pressure area inside the exhaust system to extract crankcase pressure, it's easy to see how the discussion could be extended into studying the slightly larger relationship between the airframe and exhaust collector outlet. While that is a substantially more complicated undertaking, it's something we take into account and of which we hope to continue to gain a thorough understanding. For now we continue to be challenged by airframe designs that make aero improvements the top priority and keep us on our toes by giving us a bit of thought to efficient exhaust system fitment. IAC

Flight Helmets and Risk Management

BY RICK VOLKER, EAA 23297

The benefits of flight helmet wear are well-documented and seem to offer the ultimate in risk management for the aerobatic pilot. Almost every conceivable flight emergency exposes the pilot to dangers of severe head injury. The ability to bail out is a valuable safety net, yet the decision to use the parachute triggers a sequence of dangerous impact events. Departing canopies can deform and rake through the cockpit, striking the forehead with the force of a hammer. Pilots who jump out of aircraft frequently collide with the airframe, sometimes with tragic head injuries. Once the parachute opens, the skull-jarring tuck-and-roll arrival is comparable to jumping off a 10-foot-high platform and can be complicated by gusty surface winds that will drag the pilot across uneven terrain like a rag doll. Thus flight helmets and parachutes appear to be inseparable safety aids.

The decision to stay with a stricken aircraft creates a different array of impact challenges. Tight shoulder harnesses will stretch under sudden stoppage until the head hits the panel in many aircraft. A passenger becomes a projectile. Off-field landings frequently end upside down, exposing the unprotected head directly with the hard ground. Veterans of the sport of aerobatics can probably attach a name or face with each of these emergencies, and with a case where a flight helmet saved the day.

Attempts to address the negatives of flight helmets have been swept under the rug...until now. Limitations must be recognized and minimized. Several designs will be offered in this article to help make a personal decision that will contribute to the growing culture of safety in the sport of aerobatics. Peer pressure supports flight helmet use. What could possibly prevent you from wearing a hard flight helmet?

Canopy Clearance

Flight helmets occupy between 1 inch and 2 inches of the

space above the head, depending on the visor style and fit kit used for internal padding. Aerobatic aircraft are designed with canopies that minimize the space between a pilot and the 3-D world, for reasons of aerodynamics, weight, and to maximize visibility. They aren't designed with helmets in mind. A small number of pilots will find that, despite reclining and lowering the seat, harnesses and necks stretch enough during inverted flight to eliminate the necessary head-to-canopy clearance present during positive *g*. These pilots won't be able to wear a helmet for aerobatic flight without risking canopy breakage and neck injury. For pilots determined to wear a helmet at any cost, consider making other equipment changes. A wedge backpack parachute changes seat geometry, lowering the head by half an inch. In experimental aircraft, higher-profile canopies can be built or may already be available. Unfortunately, there are canopy clearance problems that can't be solved without changing aircraft—or heads!

Campbell Aero Classic has the lowest profile of any helmet available, with a leather finish that is kind to acrylic. Canopy clearance with this helmet/aircraft will be zero during outside maneuvers. This pilot selected in-the-ear headsets for unlimited aerobatic flight to maximize canopy clearance and minimize weight. The Campbell helmet is worn in this aircraft for flights with mild aerobatics, such as in formation or photo flights.

Helmet Weight

Tests done by the military show that a majority of fighter pilots accumulate soft and hard tissue neck injuries from both sustained and momentary high *g*-loads during their careers. Flight helmet weight has proven to be a major factor. Some top air show performers and competition pilots have accumulated *g*-induced neck problems that occasionally limit their flying. Given this information, aerobatic pilots must decide whether impact protection is worth adding a 2-pound helmet to a 10-pound head, the equivalent of transferring 20 percent more g-load to the neck structure, thus jeopardizing the health of the pilot.

Pilots who wear flight helmets must develop a strategy to reduce the chance of neck injuries. Aerobatic pilots are well-acquainted with the benefits of a disciplined physical workout regimen. This should be expanded to include specific warm-up and strengthening exercises for the neck; despite the improved *g*-tolerance of a reclined seat, this position causes the neck posture to be flexed forward, greatly increasing the chance of injury. Pilots should limit turning the head under high *g*-load, the behavior that demonstrates the highest incidence and greatest severity of neck injury. The unexpected *g*-loads experienced as a passenger or coach during an aerobatic flight can cause instantaneous severe injury. It may be wise to let someone else teach snap rolls to the new S-2B owner. Ouch! These behavioral changes will enable a majority of pilots to manage the increased weight associated with a helmet.

Sound

Depending on helmet fit, sound attenuation may be poor in comparison to active noise-canceling conventional headsets. Flight Suits Unlimited, Headsets Inc., and ANR-Headsets.com sell some of the best-known kits for adding active noise capability to a flight helmet for $169 to $228. Communication ear plugs (CEPs) can be added, offering passive noise attenuation that parallels active noise systems and can cost as little as $100. Custom ear seals are available for most military-spec designs through Oregon Aero ($58). Custom liners are available through Gentex (X-liner, $112) and Oregon Aero (ZetaLiner, $99). Increased helmet coverage and mass offer vibration dampening for bone-

transmitted sound that completes the protection. Many options exist to dispel the myth that sound will be a limiting factor when wearing a helmet.

Heat

Helmets have the potential to increase core body temperature in heat-challenging environments until *g*-tolerance is diminished. Pilots exposed to extreme heat environments lose an average of 0.8 g-tolerance before *g*-LOC (*g*-induced loss of consciousness). Aerobatic contestants are occasionally faced with performing Unknown sequences under extreme environmental conditions. Despite good hydration, adequate practice, great g-tolerance, and maximal straining, a pilot can suddenly experience A-LOC (acceleration-induced almost loss of consciousness) during the perfect storm of heat and sequence design. Adding a hard helmet, flight suit, and gloves will produce an even higher core body temperature. *G*-tolerance may become depressed enough to allow the pilot to go into *g*-LOC before a decision to abort. What options can minimize this risk?

Methods to combat heat effects include more practice, adequate hydration, sitting in an air-conditioned place for 15 minutes before a hot flight, wearing frozen neck dressings, and sacrificing hot flight suits. Experience wearing a helmet in practice under extreme conditions allows a pilot to learn the limitations of this important aid. Strategies can be devised to enable a pilot

Helmets were rare in the Texas heat at the 2010 U.S. National Aerobatic Championships. Photo by Laurie Zaleski.

to manage the increased heat from wearing a helmet.

Selecting a Flight Helmet

The perfect helmet doesn't exist. All existing designs compromise one important characteristic to gain another. "Maximum" protection can be achieved, only by the sacrifice of canopy clearance and increased weight. The pilot is left to balance the strengths and weaknesses of various helmet designs as they apply to personal aircraft type, neck strength (health), environment, and financial considerations. Here's a sampling of the different designs of flight helmets available today:

1) Military flight helmets—the only helmets designed to meet established standards in impact protection for fixed-wing aircraft.

Gentex HGU-55: 31 ounces (size: large), $808 to $908

This is the lightest military-spec helmet. It has the best canopy clearance of any military design.

HGU-55

HGU-68

Gentex HGU-68: 37 ounces (size – large), $1,268

Does the aircraft have a fixed windscreen? What happens when the canopy inadvertently comes off? Will the pilot be able to maintain control of the airplane with 200-mph air blasting the eyes? Is the pilot's flight environment crowded with birds? This helmet has a visor system that has passed 600-mph ejection tests. Weight and canopy clearance are slightly compromised.

HGU–33

HGU-33: 36 ounces (size: large), protective visor housing, highest profile, $758 to $984

The most commonly found flight helmet design, spawning countless clones. The least canopy clearance of the military-spec designs. Good protection of visor integrity.

Gallet flight helmets: 32 ounces, $1,243 (and up), through Merit Apparel

Possibly the best protection available. Meets and exceeds military spec and has worldwide following with respect to quality

Gallet

and comfort. 600-mph visor available. Canopy clearance similar to HGU-33. Gallet offers active noise and CEPs as options. Available with helicopter protection standards (higher level of protection than fixed-wing).

Note: Used or surplus military helmets will not likely meet modern impact standards due to degradation of materials or unknown design.

2) Campbell Aero Classic: $2,173 base in today's New Zealand dollar

– Leather-covered carbon fiber shell, 32 ounces
– Lowest profile of all designs, as little as ½-inch thickness above head
– Custom fit included
– Less restrictive field of vision than military spec; can be ordered without goggles
– Leather is kind to canopy
– Custom finishes, models
– Not built to flight helmet military-spec standards; anecdot-

al and testimonial claims of impact protection available

– Optional face mask mic enclosure offers limited protection from fluids and fire and allows good mic performance in extreme noise environments

– Can be upgraded with active noise or CEPs

3) Headset add-ons

– Don't follow any standards for impact protection

– Cost-efficient

David Clark "K" helmet: 42 ounces with DC headset, snap-on visor available, $359

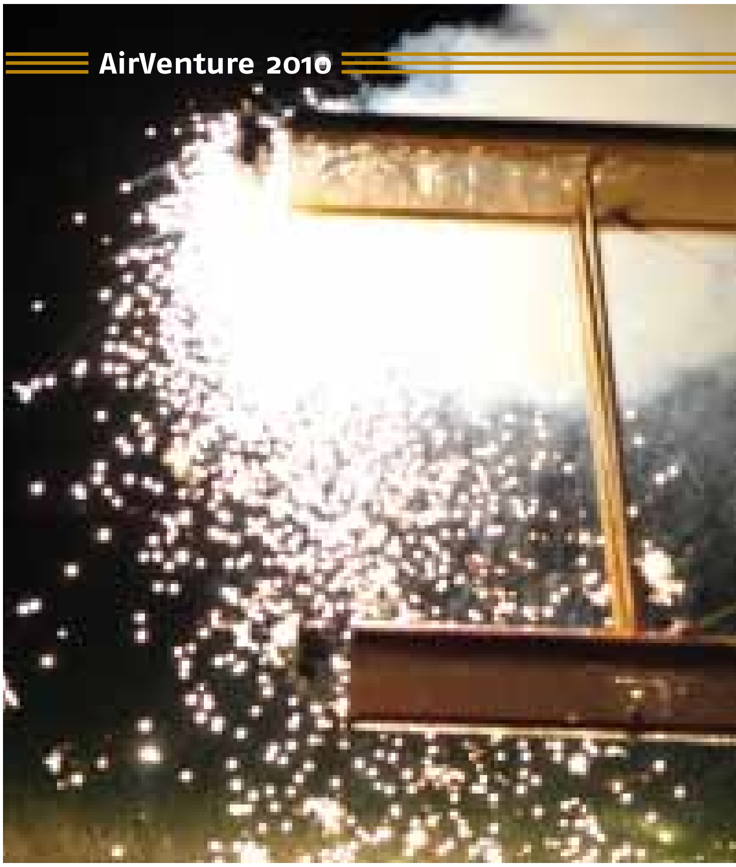
Sport-Link GA detach helmet: no weight listed, available through Aircraft Spruce, $189

David Clark flight deck helmet: about 10 ounces added to headset weight, $216

– Developed specifically for the flight decks of all U.S. aircraft carriers to be used in conjunction with a conventional headset

– Uses a mesh soft helmet carrier for the pads and shell covers that surround the headset

– Not designed to meet specific impact standards of a flight helmet



– Shells available in many colors

– Canopy clearance limited by the headset selection.

Flight helmets have the potential to improve survival in many of the emergencies that have become commonplace in the sport of aerobatics, as pilots are exposed to a different set of risks than would be realized during mainstream general aviation. Equipment is often focused on performance at the expense of all other parameters. Aerobatics pushes the design envelopes of aircraft and pilot, shortening the fatigue life of both mechanical and human parts. Aerobatic pilots learn to manage this risk with thoughtful choices in training, equipment, and behavior modification. The decision to wear a helmet, based on the juggling of many different and interdependent risks and benefits, must remain an individual choice. It's only then that this proven safety aid will gain complete acceptance in a sport that values personal freedom equally with the freedom of 3-D flight.

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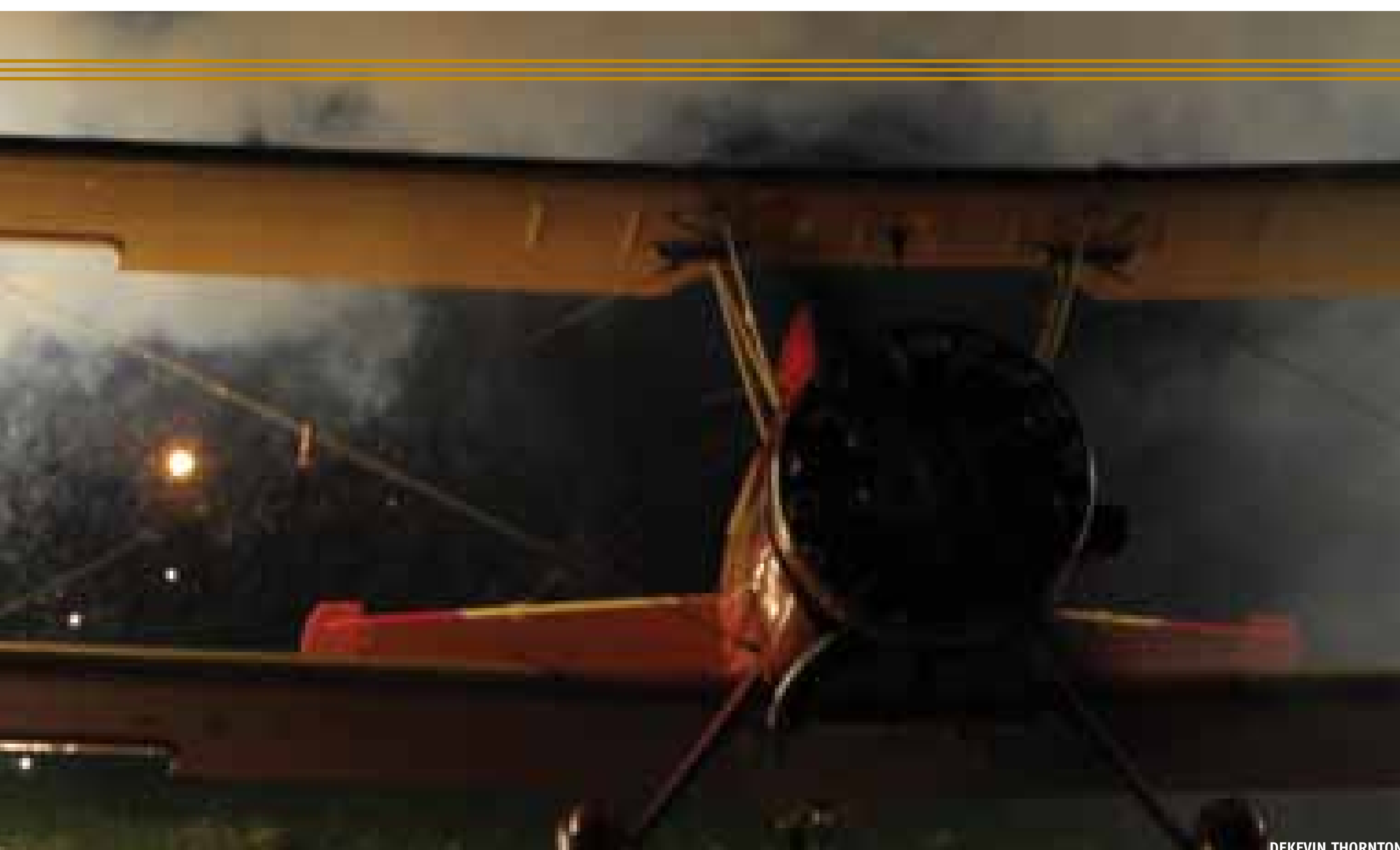


DEKEVIN THORNTON

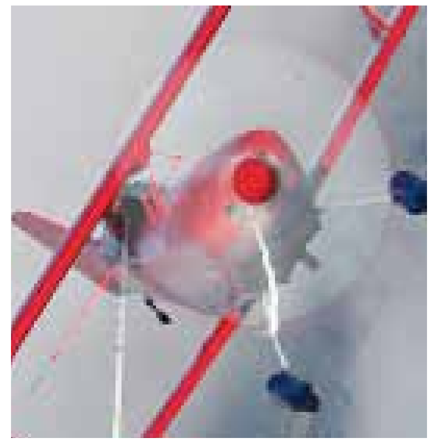
Overload Plus Overweight an Equal Tragedy

by Bob Davis, IAC 103
Reprinted from *Technical Tips Manual* I, p.12

A Pitts pilot has always taken much comfort and peace of mind from the universal conclusion, "you can't pull a Pitts apart." A few examples of this thinking: "I did a head on snap-roll at 170 mph in an airshow" or "Don't worry about overstressing a Pitts in a pull-up. You will blackout before you damage the structure." Unfortunately, this pleasant feeling of security has been abruptly dispelled. A recent incident and tragic fatal accident have proven beyond any doubt that a Pitts, strong as it is, can be flown to the point where the structure will fail.

The incident: This aircraft's engine was changed from a 180 hp Lycoming with fixed pitch prop to the 200 hp Lycoming "Aerobatic" with constant speed prop. A large heavy oil tank was installed behind the seat with Aeroquip lines to the engine. These modifications along with additional accessories and the 230 pound pilot brought the gross weight to approximately 1250 pounds. The design limits for the Pitts are 6 positive and 3 negative at 1050 pounds. Result: After one season, the fabric was removed from the wings. All of the ribs but three were found broken with some ribs falling to the floor when the fabric was removed. The top, left rear spar was cracked on both sides. Lower wing, front spar fitting holes used for the spar to fuselage attachment fitting were severely elongated. G loading range experienced was plus 8 to minus 6. Obviously this aircraft was flown out of the design envelope and was in the process of disintegrating.

The Accident: This Pitts was flown almost entirely in airshow work. It was subjected to repeated 6-7 turn snap-rolls with entry speeds as high as 170 knots, resulting in loads of 10 to 12 G's. The pilot sincerely felt that the Pitts design was more than adequate for these maneuvers. The morning of the accident the pilot was practicing for the airshow later in the day. An eyewitness stated that after a tail slide, a pull-up to vertical was started and at this point, the upper right wing separated. The right wing "I" strut fell to the ground in front of the observer, then the upper right wing. The aircraft started a roll to fuselage, contacting the ground approximately 2500 feet from the initial pull-up. Examination of the wreckage disclosed separation of the top right wing at the inboard rib adjacent to the center section. All flying wires were intact and still attached to the main body of the wreckage. The flying wires attached to the top right wing had been pulled out of the wing along with a 3-inch section of both front and rear spars. All the avail-



able evidence indicates that the failure was caused by repeated high G load applications resulting in progressive damage and eventual failure. The first incident described damage to the top, left spar. It is interesting to note that the wing failure of this accident occurred at the same spot, i.e., inboard rib next to the center section. This would appear to be an excellent area to check closely on pre-flight. There are many lessons to be learned from these accounts and every aerobatic pilot should evaluate his flying habits with these examples in mind.

One lesson is very obvious: When any aircraft is flown out of its design limits, whatever the reason, overweight, overstressing or a combination thereof, can only result in damage with highly probable fatal consequences.

A Theory—Tragedy Spawns Safety Idea

by F. H. "Moon" Wheeler, IAC 1632
Reprinted from *Technical Tips Manual III* p. 89

The tragic accident that took the life of our friend, Amos Buettell, has once again focused our attention on aircraft technical safety. Amos would be the first to say that we should learn something from his accident, and I agree with that. Herewith is an attempt to honor Amos by trying to find a lesson that his death might teach us.

There has been much discussion in regard to the accident, mainly in regard to fuel system failure due to vibration resulting from prop counter-weight failure. It has been said that the fuel line from the main tank to the header tank was a hard (aluminum) line rather than a flexible line and should have been flexible to preclude failure induced by vibration. I will not address these aspects since others will undoubtedly do so, but instead will advance a theory that I believe merits consideration.

I have been closely associated with gasoline fueled engines for many years, and I have seen many engines running with raw gasoline pouring over them without resultant fire. Bad carburetor floats, stuck needle valves, loose fittings and broken fuel lines have sprayed gasoline over hot, running engines, including the manifolds, without causing a fire. Where a fire did occur, there was always a source of ignition—usually an ignition wire with poor insulation that allowed a spark to leak out and ignite the fuel vapor. I never saw a fire caused by the engine exhaust, probably because the exhaust flame was contained within the exhaust system and because of the exhaust pressure, fuel vapor could not reach it.

In most of our aerobatic aircraft, however, the exhaust stacks are short and open, unbaffled by mufflers. Therefore, exhaust flames could possibly escape the stacks and ignite any fuel vapors present. As to why it did not do so until Amos was on downwind I offer the following speculation.

Exhaust stack flames vary in length according to the fuel mixture setting, with rich mixtures causing longer flames than lean mixtures. We can't see the flames in daytime, but they are always there. And when the throttle is retarded for landing, the mixture is automatically enriched and we get a lot of "popping" which indicates that explosions are taking place in the exhaust stacks, shooting out flames which can ignite any fuel vapors present.

Is it possible that if Amos had not pulled back the throttle, but instead had left it alone and shot down the engine with the mixture control or with the mag switch, that no fire would have occurred? I suspect that it is not only possible, but probable, and that we would be wise to adopt this procedure whenever a fuel leak is known or suspected. The

pilot will then be faced with a dead stick landing, highly preferable to a fire. Shutting the engine down with the mixture control may be better than using the mag switch, however, since a restart after mag switch shutdown would surely result in an explosion in the exhaust and emission of flame.

It occurred to me that longer exhaust stacks might be the answer, but how long should they be? A phone call to Lycoming confirmed a suspicion—they have no data for length of exhaust flames because they never had a need to know.

Please note that I do not advocate any particular course of action here. This is all theory, offered in the hope that with the input of the results of other IAC members' observations and experiments we may someday develop a procedure beneficial to all.

Oh, and by the way, have a kind thought towards Amos once in a while. Maybe he taught us something important. IAC

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MANAGER			
Trish Deimer	P.O. Box 3086, Oshkosh, WI 54903-3086	920/426-6574	tdeimer@eaa.org

***SP.O.RT AEROBATICS* EDITORIAL OFFICE**

EDITOR			
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Gerry Molidor	5912 Whiting Dr.ive, McHenry, IL 60050	815/344-3239	gmolidor@aol.com
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Lorrie Penner, Chair	7628 Plainfield Rd., Cincinnati, OH 45236	513/791-7331	penn.lorr@yahoo.com	
AEROBATIC INSTRUCTION				
Rich Stowell, Chair	P.O. Box 190, Santa Paula, CA 93061-0190	805/525-2037	rich@richstowell.com	
AWARd.S				
Ellyn Robinson	812 Juniper St Jenks, OK 74037-2554			
CIVA RELATIONS				
Mike Heuer, Delegate	4547 West Woodlawn Circle, Collierville, TN 38017	901/850-1301	mike@mheuer.com	
Debby Rihn-Harvey, Alt. Delegate	10446 Carlow Lane, La P.O.rte, TX 77571-4214	281/470-8456	hurricane@sbcglobal.net	
Doug Bartlett	1972 ConcoRd. Dr., McHenry, IL 60050	847/875-3339	Doug.bartlett79@gmail.com	
Norm DeWitt	148 Magnolia Dr.ive, Atherton, CA 94027	650/321-8499	norm.dewitt@gmail.com	
Greg Dungan	46152 Levitan Way, Great Mills, MD 20634	301/994-0083	greg.dungan@verizon.net	
Brian HowaRd.	721 West Silver Eagle Court, Tucson, AZ 85755	520/531-9151	bk@newattaero.com	
Don Peterson	612 Mary Street, Carson City, NV 89703	775/230-1555	autotech@flash.net	
Trish Deimer	P.O. Box 3086, Oshkosh, WI 54903-3086	920/426-6574	tdeimer@eaa.org	
COLLEGIATE PROGRAM				
Charles RoDr.iquez, Chair	309 E. Industrial Park Rd.., Murphysboro, IL 62966	618/453-9215 (B)	crod@siu.edu	
Pat Anderson	105 Carnival Dr.ive, Daytona Beach, FL 32114	386/226-6917	386/453-4900	andersop@erau.edu
E. Allan EnglehaRd.t	910 Burris Avenue, Lake Bluff, IL 60044-1516	847/234-2325	847/234-2325	eallanenglehaRd.t@compuserve.com
Ryan Carlson	5 GaRd.en Circle NW, E. Grand Forks, ND 56721-1256	218/779-4096	rcarlson@aero.und.edu	

COMPUTER SCORING/TECHNICAL			
Bob Buckley – IAC Scoring Program	6090 Fescue Dr.ive, Colorado Springs, CO 80918	719/721-8729 (B)	bwanaBawb@Comcast.net
Peter Jensen – contest registration	310 Ellmar Oaks Loop, San Jose, CA 95136	408/281-8654	pmj@sbcglobal.net
Tom Myers – IAC Scoring Program Chair	443 Leland Avenue, Palo Alto, CA 94306-1131	650/328-2141	tom.myers@stanfoRd.alumni.org
Randy Owens – IAC Scoring Database, Soucy, Regional Series & Collegiate Tabulations	6585 E FoRd.ham Cr., Anaheim Hills, CA 92807	714/250-1291	Rd.owens@sbcglobal.net
Doug Lovell – Scoring Outputs	8 Louden Dr.ive #6, Fishkill, NY 12524	914/456-1594	doug@wbreeze.com
DJ Molny - web	9290 Bauer Court, Lone Tree CO 80124	303/799-0149	djmolny@yahoo.com
Reggie Paulk – blog, website, wiki	5612 S. Biloxi Way, Aurora, CO 80016	303/952-4753	reggie.paulk@gmail.com
CONTEST SANCTIONING			
Doug Bartlett	1972 ConcoRd. Dr., McHenry IL 60050	847/875-3339	doug.bartlett79@gmail.com
Bob Hart	3019 N Ringwood Rd., McHenry, IL 60050-1324	815/363-8967	hrtlndfrm@aol.com
Brian HowaRd.	721 West Silver Eagle Court, Tucson, AZ 85755	520/531-9151	bk@newattaero.com
Trish Deimer	P.O. Box 3086, Oshkosh, WI 54903-3086	920/426-6574	Tdeimer@eaa.org
EXECUTIVE COMMITTEE			
Doug Bartlett	1972 ConcoRd. Dr., McHenry IL 60050	847/875-3339	doug.bartlett79@gmail.com
Doug Sowder	118 East High Dr., SP.O.kane, WA 99203	509/747-5748	dsowder@aol.com
Ellyn Robinson	812 Juniper St Jenks, OK 74037-2554	918/805-4031	ellyn.robinson@yahoo.com
Bob Hart	3019 N Ringwood Rd., McHenry, IL 60050-1324	815/363-8967	hrtlndfrm@aol.com
FINANCE COMMITTEE			
Doug Bartlett	1972 ConcoRd. Dr., McHenry IL 60050	847/875-3339	doug.bartlett79@gmail.com
Doug Sowder	118 East High Dr., SP.O.kane, WA 99203	509/747-5748	dsowder@aol.com
Bob Hart	3019 N Ringwood Rd., McHenry, IL 60050-1324		
Trish Deimer	P.O. Box 3086, Oshkosh, WI 54903-3086	920/426-6574	tdeimer@eaa.org
GLIDER AEROBATICS			
Klein Gilhousen	599 High Tower Rd., Bozeman, MT 59718	406/586-2517	kleing@qualcomm.com
GOVERNMENT RELATIONS REPRESENTATIVES			
Bill Finagin, National	6 Romar Dr.ive, AnnaP.O.lis, MD 21403	410/263-2740	wbfinagin@cs.com
Doug Bartlett, Mid-America/SouthCentral	1972 ConcoRd. Dr., McHenry, IL 60050	847/875-3339	doug.bartlett79@gmail.com
Darren Pleasance, Northwest/Southwest	30 Roxbury Lane, San Mateo, CA 94403	650/212-1806	darren.pleasance.1995@anderson.ucla.edu
Dennis Thompson, Northeast/Southeast	83 Church Street, High Bridge, NJ 08829	973/219-5071	dtedge2002@yahoo.com
HALL OF FAME			
Dave Lammers, Chair	4000 Meadowknolls Rd., Marion, IA 52302	319/377-1425	davelammers@mchsi.com
Clyde Cable	21095 W. County Rd. 72, Eaton, CO 80615	970/227-5421	jinnyfield@yahoo.com
Bob Davis	N1561 Linn Rd., Lake Geneva, WI 53147	262/248-6364	bdavis74@charter.net
Linda Hamer	20483 Meridian Rd., Peru IL 61354-9801	815/223-8596	l.hamerrealty@sbcglobal.net
Verne Jobst	2921 Sterling Dr.ive, McHenry, IL 60050-2662	815/385-7277	nx211@owc.net
Clint McHenry	180 Sweet Bay Avenue, New Smyrna Beach, FL 32168		
Dr.. RichaRd. Rihn	1101 Scots Lane, Walnut Creek, CA 94596	925/938-4236	rihnairco@aol.com
HISTORIAN			
Mike Heuer	4547 West Woodlawn Circle, Collierville, TN 38017	901/850-1301	mike@mheuer.com
ICAS LIAISON			
Bob Davis	N1561 Linn Rd., Lake Geneva, WI 53147	262/248-6364	bdavis74@charter.net
JUDGES – CERTIFICATION & SCHOOLS			
Greg Dungan, Chair	46152 Levitan Way, Great Mills, MD 20634	301/994-0083	greg.dungan@verizon.net
LEGAL COUNSEL			
Louis AnDr.ew, Jr.	39 South Marr Street, Fond du Lac, WI 54935	920/921-6000	lanDr.ew@eaa.org
MEMBERSHIP			
Doug McConnell	4203 E. Lake Shore Dr.ive, Wonder Lake, IL 60097	815/653-1044	doug_mcconnell@comcast.net
NOMINATION			
Ann Salcedo, Chair	20117 SW 54th Pl, Fort LaudeRd.ale, FL 33332-1548	954/434-1659	AnnSalcedoRN@aol.com
RULES COMMITTEE			
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Greg Dungan	46152 Levitan Way, Great Mills, MD 20634	301/994-0083	greg.dungan@verizon.net
Bob Hart	3019 N Ringwood Rd., McHenry, IL 60050-1324	815/363-8967	hrtlndfrm@aol.com
Klein Gilhousen	599 High Tower Rd., Bozeman, MT 59718	406/586-2517	kleing@qualcomm.com
Martha Martin	3279 La Villa Rd., GrafoRd., TX 76449	940/779-3986	pkakro@earthlink.net
Doug Bartlett	1972 ConcoRd. Dr., McHenry IL 60050	847/875-3339	Doug.bartlett79@gmail.com
SAFETY			
Open	3061 Oak Grove Rd., Hattiesburg, MS 39402	601/264-3752	N5ue@aol.com
Human Factors			
Scott P.O.ehlmann	825 Wingfoote Rd., El Paso, TX 79912	915/307-6450	Scott-p@texas.net
Technical Safety			
Doug Bartlett	1972 ConcoRd. Dr., McHenry IL 60050	847/875-3339	Doug.bartlett79@gmail.com
GENERAL INFORMATION & MEMBER SERVICES			
CHAPTER RELATIONS			
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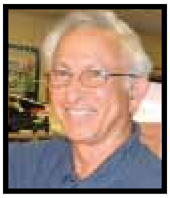

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Q: What is a parachute diaper?

A: No, it's not something to help prevent pilots from soiling themselves during a bailout. Rather, a parachute diaper is a simple piece of material that ensures your parachute opens properly and helps prevent injuries during deployment.

When you hear the word diaper, you probably think of something wrapped around a baby's bottom. Similarly, a parachute diaper is wrapped around the bottom, or skirt, of your parachute where the lines are attached and keeps all the "crap" contained during certain critical stages of the parachute's deployment.

While an emergency parachute deployment looks like a blur, it is actually a carefully engineered series of events that takes place within three seconds of pulling the ripcord.

To appreciate the diaper, let's go back in history and see how parachutes worked before the diaper came into use. The lines of the parachute were neatly stowed in the container with rubber bands (see photo 1), and the parachute was folded and packed on top of the lines. When the ripcord was pulled, a small spring-loaded drogue (pilot chute) extracted the parachute from the container. As soon as the parachute was all the way out of the container, it opened and began decelerating. But the lines were still coming out of the container as you hurtled toward the earth at full speed.

When you reached the end of those lines (called "line stretch" in parachute talk), you got a rather violent opening shock as the fully inflated parachute above you acts like an anchor. The lines go slack as you snap around like a rag doll at the end of a rubber band. This could easily cause a type of malfunction called a "line over," where some lines would flip over the top of the parachute. Because this condition sometimes made the parachute look like a bra, it was also known as a "Mae West." If you're too young to know who Mae West was, Google her. This malfunction often broke lines, ripped the parachute material, caused your parachute to spin violently, or all of the above.

In addition to the line over, there was the real possibility of becoming entangled with the lines if you were tumbling during the parachute's deployment. Tumbling in a bailout is a likely scenario, since most pilots are not trained skydivers and an out-of-control or burning airplane is very different from the stable, controlled environment at a skydiving drop zone. Entangling with the lines could prevent the parachute from opening and have catastrophic results.

Around 1970 some brilliant person came up with the idea of the partial-stow diaper (see photo 2). Wrapped around the skirt of the parachute, this was a small piece of material that would not allow it to inflate until reaching line stretch, at which point the lines holding the diaper closed (called locking stows) were released (see photo 3). Photo 4 shows the diaper fully open, allowing the parachute to inflate. All manufacturers of pilot emergency parachutes quickly adopted the partial-stow diaper.

What a marvelous improvement. Not only did it almost entirely eliminate the line-over malfunction, but it also eliminated that first violent opening shock. Now, you got nailed only once and it was a lot less severe.

But since only part of the lines were stowed on the diaper, there was still the danger of becoming entangled with the lines. Enter the full-stow diaper. In the late 1970s someone came up with another great idea. By adding more rubber bands, almost all of the suspension lines could be stowed on the diaper (see photo 5) and not in the container. Now, when you pull the ripcord and the parachute is coming out of the container, it takes all but about a foot of the suspension lines with it. If you do get entangled with the lines, it should only be with those lines closest to your body and hopefully should not prevent the parachute from opening.

Today, all but one manufacturer of pilot emergency parachutes use the full stow diaper system. While both partial and full stow diapers work very well, I personally prefer a full stow diaper. It helps eliminate one more risk and prevents a bad day from getting worse.

Now that you understand how a diaper works, you can appreciate the importance of regular maintenance on this simple yet critical component of your parachute. Regulations call for a 180-day repack cycle. It is your responsibility to get your parachute serviced by a rigger who has all the replacement parts your parachute might need, like those vital rubber bands on the diaper. If they deteriorate and break between repacks due to improper care and long intervals between servicing, you could get an out-of-sequence opening. This could cause serious problems. Make sure your rigger has the proper tools and a clean area to pack your expensive cushion should go without saying.

Until next time, fly safe! IAC


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