The 10th Annual CAFE 400, "Competition in Aircraft Flight Efficiency", was held June 21-23 at the Santa Rosa Air Center. This spacious former Navy base is now a private general aviation field in the Sonoma wine country of California. The CAFE Foundation decided to mark their decade of success with some special new features. These were the First Annual CAFE 400 Designer's Forum, the First Annual CAFE 400 Propeller Contest, and the First Annual CAFE 400 Car Versus Airplane contest. All three of these new endeavors were great successes.

**CAFE 400 Designer's Forum**

The Designer's Forum was an invitation-only gathering of very well-known experts in various fields of aircraft design. They each spoke at the evening program on the topics listed below, and the proceedings were video-taped by Rolling Video Productions for future public release by the CAFE Foundation. These videotapes should be available in mid-September by writing to Larry Ford, CAFE Foundation, 855 Regle Rd., Sebastopol, CA 95472.

**1990 CAFE 400 Designer's Forum Program**


By Brian A. Seeley, M.D.

EAA 120126
4370 Raymonde Way
Santa Rosa, CA 95404

Jim Griswold: Questair Venture Control Springbox to Ease Pilot Workload.
Ben Ellison: Improved Mixture Leaning With the Ellison Throttle Body.
Roy LoPresti: Siv-Flite Detail Drag Reduction Program.

Klaus Saviar: Advanced Ignition Systems for Improved Efficiency.
Everett Hatch: Performance Modifications for Lycoming Engines.
Steve Beckham: Aircraft Rotary Engine Development Project.

The forum was very rapid-fire, and these designers spent many hours dur-
ing the rest of the event furthering their discussions and interchange of ideas on the above topics. The CAFE Foundation hopes to make this program a regular attraction at future CAFE 400 events.

CAFE 400 Propeller Contest

Fred Cook of Great American Propeller Company proposed in 1988 that the CAFE 400 sponsor and stage a fair competition for fixed-pitch wooden propeller makers using the very accurate CAFE barographs to record performance. Dick VanGrunsvsen of Van’s Aircraft, designer and supplier of the RV series of aircraft, was asked to serve as test pilot for the event. He graciously agreed, and the RV-6 was chosen as the “mule” for the competition. Dick was an ideal test pilot because he had demonstrated repeatedly in previous CAFE Triathlon events that he could hold airspeed and altitude better than any of the other pilots. He also has a rock solid reputation as an honest, fair-minded member of the homebuilt aircraft movement. We hoped the competition would aid in the development of a wider choice of propellers for aircraft of comparable power and speeds.

The pit crew, which consisted of Dick, Everett Hatch, Steve Beckham, Bill Van Sice, Bill Bruce, Ted Smith, Bill Genevro, and many others, became very skilled at changing propellers on the RV-6, and after each flight, they attacked the nose of the aircraft and had a new fan on in just over 20 minutes. 8 propellers were tested, 6 of which were in the competition.

For each prop test, Dick obtained static rpm, and then recorded climb rpm, climb manifold pressure, and climb horsepower at 2000' MSL while holding 105 IAS. After reaching 8000', he leveled off and recorded cruise manifold pressure and horsepower while maintaining a constant 2600 rpm. Finally, he used full throttle, level at 8000' and recorded maximum rpm. The CAFE barograph meanwhile was recording climb rate, OAT, and airspeed continuously. The horsepower figures are direct conversions from the very promising new tool, a BMEP meter, from Bill Genevro.

The BMEP meter uses an aircraft spark plug into which a small caliber stainless steel tube has been welded. The tube is routed through the firewall to the instrument panel and is connected to a direct reading psi gauge. Bill calibrates the instrument and can determine in-flight engine horsepower to within about 1%.

The wooden propellers in the contest were from Bernard Warnke, Ed Sterba, Harold Rehm, Props, Inc., Great American Propeller, and Pacesetter. A metal fixed-pitch Sensenich and a metal Hartzell constant speed prop were tested for comparison. Other propeller makers who were invited and chose not to enter were: Aymar-Domitch, Prince Aircraft, Hegy, Ted Hendrickson, PropAir, Warp-Drive and MT Propeller.

The award for Best Cruise was given to Harold Rehm, and the Best Climb award went to Ed Sterba. It is worth noting that the Props, Inc. entry was fairly similar to that of Harold Rehm in most categories of performance. The Warnke prop seems to have the most well-balanced performance, showing respectable static rpm, climb, cruise and Vmax.

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<th>Contestant</th>
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Notes: All climbs were flown in the RV-6 Prototype by Dick VanGrunsvsen at 105 IAS. Climb data was recorded at 2000' MSL and climb rate is an average from 1000-4000'. Climb BMEP readings were all nearly identical at 54-55 psi for all wood props.

Engine was Lycoming O-320 E1F, 160 HP. Same spinner was used on all runs.

All wood props can be purchased and range in price from $400-$650.

Addresses: Ed Sterba, 412 S. 5th St., Delavan, WI 53115.

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Props, Inc. 2020 S. Susan, #40 Santa Ana, CA 92734.
Warnke Props, HCR 1717, Tucson, AZ 85736
H. A. Rehm, 5103 Petty Lake Road, Dousman, WI 53118.
Pacesetter Props, P.O. Box 1245, Hillsboro, OR 97123.
Great American, 1180 Pike Lane #5, Oceano, CA 93445.
Sensenich Props, P.O. Box 4187, Airport Road, Lancaster, PA 17604.
The Great American entry nearly won the climb contest, but, like the Sterba prop, too flat pitched for cruise. The thin bladed Sensenich metal prop should out perform the wood props, but it does so by a relatively small margin when compared to the Rehm prop. The Hartzell prop cruised faster by 8 mph than the Rehm, but did so using 12 more horsepower.

We suspect that 1991 will see better performing props from these participants as well as an even wider field of entries.

First Annual CAFE 400 Car Versus Airplane Contest

The original CAFE 400 formula, SPEED times MPG times PAYLOAD, enjoys the distinction of being founded on sound physical principles. It was originally derived by the noted physicist Von Karmann, and was later articulated for aircraft by Bud Carson at the U.S. Naval Academy, and by myself in separate treatises. The beauty of this formula is that it serves as a rational and correct measure of the efficiency of any vehicle, from car to jet to ocean liners.

I became intrigued with the idea of using this formula to compare a modern, showroom stock automobile with the showroom stock, fixed gear aircraft in the CAFE 400. Thanks to the foresight and enthusiasm of Steven Thompson, who is a contributing editor to Air and Space magazine and AutoWeek, this year’s event included that comparison. Chuck Hansel, of Hansel Ford in Santa Rosa, donated the use of his 1990 Ford Aerostar van, a seven-passenger, fully loaded vehicle with 3.0 liter V6 145 horsepower, automatic transmission and fuel flow computer.

Steven and his wife Lanny, “piloted” the car over a 200 mile course that included a twisting two lane road climbing over Mt. St. Helena, the first pylon for the aircraft. They carried a 1400 lb payloads, including full fuel and 1000 lbs of sand, which Steven loaded on the floor midway between the front and rear axles. He said the sand improved the polar moment and handling of the vehicle on the curving road course, which was nearly 50% non-freeway. Contending with the resort boat trailer traffic and a couple of highway construction slowdowns were challenges not faced by the aircraft, but were nevertheless “real-world” factors in measuring the car’s efficiency. They averaged 52.8 mph and 18.68 mpg.

As the results revealed, this Ford stacked up remarkably well against the aircraft, losing out to only the more modern designs. Even more surprising was the fact that the Aircraft Spruce & Specialty’s Tom Jewett Memorial Award for best overall mpg times payload would have gone to the Ford by a large margin if it had been eligible for the award. Since mpg times payload is really a measure of lift to drag ratio, and good radial tires can achieve perhaps 200 to 1 lift to drag ratio, the Ford’s performance becomes less surprising.

Where will this lead us? A CAFE competition in which an open class or a manufacturer’s championship based upon the Von Karmann formula is a real possibility. The spinoffs in aerodynamics, specific fuel consumption, alternative powerplants, fire technology, and more efficient packaging of passengers produce a new generation of commuter minivans, clean air vehicles, and high speed surface transpor-

5th Annual CAFE Triathlon

Table 2 indicates some of the remarkable scores obtained in the Triathlon. The Quest Air Venture, with its new tuned exhaust system, set a new all-time high speed or Vmax, 298.6 mph TAS, which is 2.8 mph faster than the 1989 speed. Jim Griswold had told me that the new exhaust had gained about 3 mph on the top end, so the CAFE barographs have done it again!

The Venture’s slow flight produced a curious Vmin score of 77.3 mph which is 8 mph faster than last year. The slowest one second recording at Vmin was 75.8 mph IAS and no abrupt stall in terms of altitude loss was seen during the run. We can only assume that the Venture could have flown slower if it had been pushed all the way to a stall, perhaps with a higher power setting.

Ray Richter, flying the RV-4 prototype, scored extremely well, and nearly broke the all-time high score achieved by the RV-6 prototype in the 1987 Triathlon. The speed ratio of 4.36 is outstanding.

Rich Powell, flying the 27’ span 180 hp fixed tri-gear Glissier, showed an excellent speed ratio, with a surprising Vmin of 55.5 mph.

Richard Wallrauth won his uncontested Class C-1.a in an exceptionally well built modified VariEze.

Hans Neubert’s Piper Twin Comanche won first in the C-1.c class, edging out Del Wardlow’s Helio Courier from Memphis. Del’s consolation may be that he set a new all-time record for Vmin in the event, 38.0 mph. Note that a lightly loaded Cessna 172 achieved a Vmin of 38.1 mph.

10th Annual CAFE 400

Gary Hertzler’s amazing VariEze again took home the honors. He set a new all-time high mpg score for 2-seat experimental with 49.26 mpg. To get some idea of this achievement, note that Richard Wallrauth’s VariEze, which has a number of CAFE racing refinements and modifications, placed a distant third to Gary’s. The $500 CAFE Achievement Award (most significant score relative to historical class average), $500 Aircraft Spruce Tom Jewett
Memorial Award (highest mpg times payload for experimental aircraft), and the $1000 Ellison-Bob Beard Memorial Award (highest scoring 2-seat experimental) all went to Gary. His co-pilot was Dick Townsend, who has teamed with Gary for a record 5 CAFE championships.

For 1990, Gary made several modifications to his already supremely honed Varieze. He designed, built and installed a new induction system on which the Ellison throttle body is mounted. This afforded 10" intake runners instead of the stock 2" ones, and allowed the mixture to be leaned further. The new system also passes through the oil tank under the Continental engine, which may help ensure no carb icing and better atomize the mixture.

Gary adopted CAVU’s new electronic ignition system which uses a Hall effect pickup in an automotive distributor and allows variable spark advance. He flew climb legs with 28 degrees of advance and the remainder of the course legs with 45 degrees of advance. Advancing this way allows him to further lean the mixture. They allowed a 6-8% reduction in fuel flow. (Please do not try this on your aircraft because catastrophic detonation can result.)

Gary elected to climb to 10,000 feet on the outbound course leg to Inskip Hill, and found a 9 mph tailwind there. He flew all the cruise legs at 155 TAS.

In second place, with a speed exactly 101 mph faster than Hertzler, was the Questair Venture. It is interesting to note that the calculated flat plate drag at race speed average is 1.45 square feet for Gary’s Varieze and 1.37 square feet for the Venture. The Venture’s empty weight was up about 30 lbs. this year to 1369 lbs. Rich Gritter flew the race at about 85% power. This aircraft is a real crowd pleaser at the pylons.

Third place in the 2-seat experimental went to Richard Wallrath in his Varieze, whose score is much more representative of ‘mere mortal’ Variezes in cross-country flight than that of Hertzler’s. Close on Wallrath’s heels was a diverse group of different 2-seat homebuilts.

It is interesting to note that the prototype Whisper, flown by Jim Rust, outscored the Glasairs and RV-4. It was awarded $500 as Outstanding New Design at the event.

Production Classes

Jerry Rice, who refers to his beautiful Mooney 201 as a submarine because it was salvaged from the bottom of a lake after an engine failure on takeoff, was the Cinderella story at this year’s event. In his first CAFE 400, he bested perennial Stock Class winner Cris Hawkins, whose rented 201 suffered from a high empty weight and the detail drag losses of an everyday rental fleet aircraft. Jerry’s Mooney sported all of the drag reducing modifications available from Paul’s Lake Aero Styling Mooney Service Center, excepting inboard landing gear doors.

Of the aircraft that flew the shorter race course (295 statute miles), the top score was that of Dr. Kent Carlomagno in his stock Ercoupe 415-D.

Bill McKay, who flew his Grumman AA1C all the way from Boston for the event, came farther than any other participant.

Awards Banquet

The CAFE awards banquet this year again included a great slide show with in-flight photos from the pylons provided courtesy of Bill Wright, our pylon chief. A superb presentation on Drag Reduction was given by Roy LoPresti, LoPresti Piper Aircraft, Vero Beach, FL. Jim Irwin was recognized for the decade of generous sponsorship from the Aircraft Spruce & Specialty Company. Cris Hawkins and Randy Easterling were recognized for their major contribution of designing and fabricating new trophies for the Triathlon and Special Awards on the CNC milling machine at
Randy's Design and Machine in Santa Rosa. The assistance of all of the pylon teams and sponsors was acknowledged. A fund-raising raffle awarded two beautiful David Clark Headsets.

Miscellaneous Observations

Bill Genevrio's BMEP meter opens up new horizons for obtaining accurate flight data. Using this tool along with a CAFE barograph, one can determine an accurate plot of drag versus airspeed for any piston powered aircraft. This could be a great help for drag reduction modification development, and could also even allow a competition to be set up based upon drag analysis. In addition, more sophisticated analysis of the BMEP, such as using an oscilloscope to obtain peak instantaneous BMEP, could allow very refined mixture management, spark advance control, and detonation detection, with automated regulation of same. Watch for Bill's BMEP meter to soon be available to homebuilders.

Jack Norris, in a similar development, announced at the CAFE 400 the idea that using the known force of gravity and an ingenious device called a "zero-thrust detection switch", an accurate determination of an aircraft's drag versus airspeed can be obtained by measuring zero-thrust glide airspeed and sink rate.

Looks like another job for the CAFE barographs. The zero-thrust switch mounts to the engine crankcase and detects the .006" axial movement of the crankshaft as the aircraft transitions from propeller thrust to windmilling.

The CAFE 400 has run for ten years
Left to right, Frank Braal and Steve Williams, barograph designers, fitting the boom to the RV-6 for the Triaviathon.

Lanny and Steven Thompson with their race vehicle, a 1990 Ford Aerostar.

Props used in the contest: Harold Rehm (with spinner), then Warnke, Sterba, Props, Inc., Great American, Pacesetter and Sensenich (metal).

now with yearly improvements to the event in terms of smoothness of operation, refinement of the rules and race course, addition of new events and safety features. This year, awards recognizing the decade of effort of Larry Ford, Dwayne Green, Jim Horn, Otis Hoit, Bill Badstubner and Frank Braal to create and develop this fine event were given at the awards banquet. Their totally volunteer service has created benefits for all of general aviation.

The funding of the CAFE Foundation has been a purely non-profit system, and each year we struggle to be able to stage the event. We are very grateful to all who have contributed these last 10 years. Our largest sponsor, donating $2,000, is the EAA Aviation Foundation. Their continued annual support is the only thing that has made it possible to pay for our liability insurance coverage premium of $4,400 per year.

Several people have suggested new events, new formulae, and new rules for the CAFE 400. After 10 years, it is time that our Board reconsider many of these. Included will be such things as a more credit for speed, combining the Triaviathon score with the CAFE score, staging the event at a major airshow, obtaining much larger prizes, and expanding the event to include surface transportation vehicles. We want to invite you to send in your ideas on this to CAFE Foundation, c/o Jim Horn, 210 Nila Mae Way, Penngrove, CA 94951.

Major Sponsors/Pylon Crews

Major sponsors for the 1990 CAFE 400 were:

EAA Aviation Foundation; Cribs Hawkins Consulting; Randy's Design and Machine; Ellison Fluid Systems; Aircraft Spruce & Specialty Company; Ken Brock Manufacturing; David Clark Company; Accurate Forklift; Hansel Ford; Chuck Hansel; Braal Micro Instruments; Steven and Lanny Thompson; Grando Elmer; Jerry Redmon; Bill Van Sice; Rolling Video Productions; Santa Associates II; Woody Ersted; DZ, Inc.; Steve Williams; Bill Wright; John Long; Andy Marshall; Orcon; Fred and Tak Waites; Bob Maciejewicz; Dee Tolleson; Dick VanGunsven; Dale Vater; George Mullen; Jack Norris.

Pylon crews were:

Santa Rosa Air Center: Bob Gutteridge, Brian Perkin, Mike Neil, Kim Rogers, Al Hastings, Randy Burngardner.


Inskeep Hill: Al Johanson, Lee Kratz, Steve Roberts, Mike Young.

Bully Choop: Roger Loftus, Don Deard, Dennis Perkins.

Sutter Buttes: Pete Wiebens, Melody Wibens, Mike Welch.

Dinner hosts were Anna Seeley, Donna Turrentine, Ellen Powell, Meg Hurt, Betty Stephens.