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## AIRCRAFT PERFORMANCE REPORT

Sponsored and Funded by the Experimental Aircraft Association  
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# Express

BY BRIEN A. SEELEY, C.J. STEPHENS AND THE CAFE BOARD



The Express over Lake Sonoma.

**T**he Express is the first 4-place homebuilt to be tested in the EAA/CAFE Foundation Aircraft Performance Report program. This design made its debut at Oshkosh in 1987 when Ken and Gail Wheeler of Gig Harbor, Washington began taking orders for it as a kit aircraft. The all-composite, fixed tricycle gear Express offered homebuilders a solution to their need for a family airplane, a major void in the homebuilt fleet of that time. The new company became very busy.

Ken had built a Glasair and used the construction techniques from that experience to develop the Express. The aeronautical design for the

Express was largely performed by a team working with Ken Wheeler.

The kit supply gradually caught up to the healthy demand for this aircraft and, in 1989, Jerry Sjostrand became one of the 300 who had bought kits to build the Express. Jerry has since become an expert in this aircraft and crafted the beautiful version which serves as the subject of this report, N360EZ, serial # SJ2146. There are reportedly 30 examples of the Express now completed and licensed.

### MODIFICATIONS

The kit manufacturer information lists a building time of 2000 hours for the Wheeler.

Jerry estimated his building time at 5000 hours but added that his included extraordinary attention to finish work inside and out. That effort was evident everywhere in the superb finish on N360EZ.

Jerry was a pioneer builder who, working from incomplete plans and drawings, actually created much of the documentation used by subsequent builders. He also invented many modifications during the course of his project, some of which now valued improvements incorporated by other Express builders. These include creating a baggage door/escape hatch on the right rear fuselage that was engineered with help from Chuck Ritchie at



Jo Dempsey

The Express has a cruciform horizontal tail with sweep-back.

The lower cowl was modified to allow the use of a 3 blade non-extended hub propeller from the Piper Arrow. An option of dual brake pedals was also installed.

Jerry designed the seats for quick removal and created a nifty cabin layout allowing 3 seats and a 74" long litter/baggage floor area underneath which are 2 large storage bays. These bays were covered by carpeted graphite floor panels (see photo).

N360EZ's cooling baffles were modified to become a completely enclosed 'doghouse' cold air plenum on top of the engine.

A small vent door on top of the cabin door's leading edge was added to provide

a strong blast of fresh air to the front occupants upon engine start. A second NACA inlet vent on the right side of the fuselage above the wing was installed for cabin airflow in cruise but is ineffective in climb, according to Jerry.

This Express had a Century 2000 S autopilot with altitude hold. The 27 pound radio stack included dual nav-com's, a Narco GPS/nav/glide slope/localizer unit as well as DME

and marker beacon receivers. The fuel system included a fuel return line to each fuel tank as used routinely with the Continental fuel injection system. Jerry commented that if he were to do it over again he would not have included the elaborate radio and instrument equipment.

### HISTORY OF DEVELOPMENT

Early in the aircraft's development the Wheeler Express demonstrator crashed in Santa Monica, California, reportedly due to an engine failure. The landing gear and wing damage was severe. However, the structural integrity of the fuselage and cabin observed after that crash and the lack of injury to the crew apparently had a favorable effect upon the company, serving to attest to the strength of the design. "People began calling it an escape capsule", Jerry said.

A second crash involving impact at high speed and at a steep angle to the ground killed all 4 occupants and was labeled by the NTSB as "pilot error". This occurred just prior to Oshkosh, 1990. It led to a severe contraction in sales eventually prompting Ken Wheeler to enter bankruptcy.

Meanwhile, a group of about 17 owners developed a variant of the Express initially known as the Arriga. This variation of the aircraft had the same wing and fuselage but a 13' span horizontal stabilizer with 40% more wetted area than the Express' 10' stabilizer. The Arriga tail retained some of the sweepback of the Express tail, but abandoned the cruciform tail configuration and used a conventional low-set horizontal tail. This larger tail was developed to solve some alleged problems with the cruciform tail on the Express. The cruciform tail was studied with videotaped investigations of their air flow using vortex generators and tuft tests. These were performed by a former Boeing engineer, Paul Robertson, of Arlington, Washington with a goal of certification.

The Express kit business was purchased by Dave Ulrich in Redmond, Oregon, who took over in 1992. He carried on the business for 3 years as Express Design, Inc., tooling up to sell complete kits for both the Express and the Arriga. He renamed the Arriga, calling it the Series 90, and developed a conversion kit to allow Express owners to graft on the larger tail of the Series 90. The company was again sold in late 1996 to the current owners.

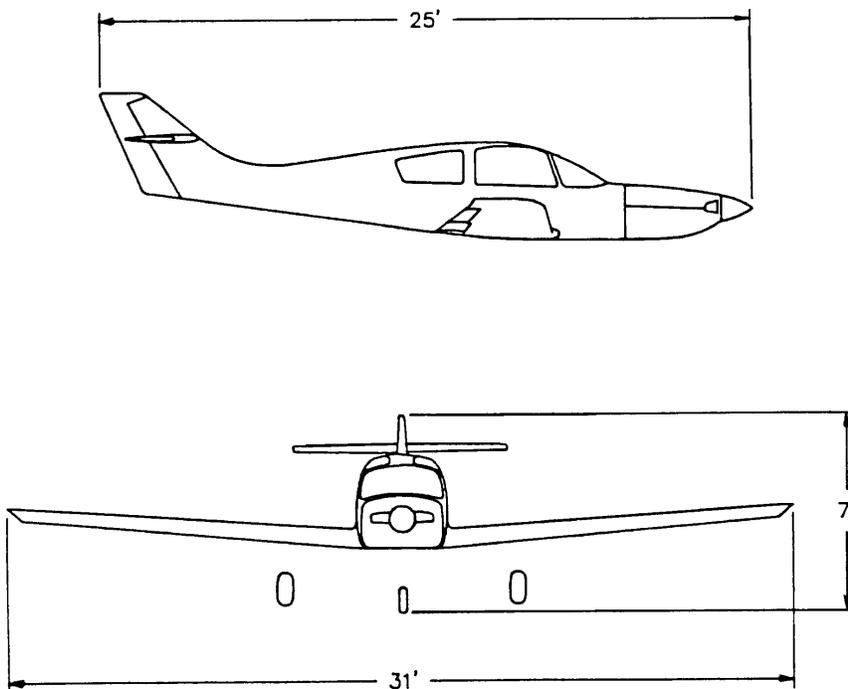
### NEW COMPANY

The third and current owners of the design are two Express builders, Larry Olson and Paul Fagerstrom, in

Scaled Composites. Precise Flight speed brakes as used on the Mooney and a center control stick with left-sided throttle quadrant were also part of Jerry's redesign. N360EZ has a Slick magneto on the left and a Lightspeed Engineering capacitive discharge ignition unit on the right side. The Lightspeed unit involves two 4 pound ignition modules in place of a conventional magneto.

### CAFE MEASURED PERFORMANCE

Takeoff distance; 120' MSL, 2 mph wind, 2582 lb. 75.2° F, Flt. #6	980 ft.
Liftoff speed; per barograph data, CAS, 2582 lb., 75.2° F, Flt. #6	86.1mph
Touchdown speed; barograph, CAS, 2400 lb., 77° F.	83.9 mph
Noise level; ambient/idle/full power climb/75% cruise	60/75/100/97 dBA
TRIAVIATHON Score	36.5



Olympia, Washington. Now known as Express Aircraft Company, they hold the rights to both the Express and the Series 90 and have plans to furnish complete kits for these aircraft by April 1998. The kits will include all the pre-molded skins, hardware and engine mount--everything except engine, prop, avionics and paint. The structure will continue to be made of vinyl ester resin-impregnated E-glass with polyurethane foam as the sandwich core. The wing spar comes already bonded to one of the wing skins. Engine options have included the 6 cylinder 360 Continental and the lightweight Lycoming 540 series. A new engine option under development will allow use of the Continental IO-550. A kit to allow converting the cruciform to the Series 90 tail is being developed to attach to their shared common area of the fuselage.

There are currently several Express builders in other countries including France, Luxembourg, Switzerland, etc.

### FLIGHT TEST DETAILS

Six of the eight CAFE test flights were performed at gross weight. Weather conditions were favorable in all of the flights excepting flight # 7, which was marred by turbulence.

Barograph #3 was used on a wing cuff mount and was compared to CAFE Barograph #1 mounted in the cabin and connected to the stock aircraft pitot static system using "T" fittings to allow the panel airspeed and altimeter to indicate their normal readings. These 3 airspeed system's data appear in the calibration table in this report. Compensation was made for the drag of the wing cuffs in determining the cruise speeds published here.

The initial climb tests were conducted using Jerry's recommended value of 70 kts (panel) as  $V_y$ . This produced a markedly high CHT and oil temperature and the climb had to be aborted. During the peak temperatures of this climb, a temp probe, shielded against radiant heating and located just inside the cowl exit, reached a reading of 234 °F. The CAFE Digital Acquisition Device and its probes survived this temperature. However, the Slick magneto coil of the left mag failed shortly thereafter.

After an intense work session to quickly diagnose the magneto problem, Jerry and some of the CAFE team were able to fly to Navajo Aviation in Concord and obtain a replacement coil on Saturday night from Mike Becker, their mechanic. Mike had been driving home from the Concord Airport with his children when his beeper ad-



Jo Dempsey

CAFE Barograph, pitot-static and boom mounted on rt. wing for first data flight at dawn on 9/20/97. Note large, gull-wing cabin door and rear baggage door.

vised of CAFE's desperate cry for help. He returned to the airport to meet our crew, installing the new coil for them on the spot. "No charge for the mag coil," said Mike, "just ship me a replacement when you're done testing the Express!"

Subsequently, extensive efforts were made to determine  $V_y$  and  $V_x$  for this aircraft, and these were found to be 98 and 75 kts, respectively, on the aircraft's instrument panel airspeed indicator. These correspond to 116 and 88 mph CAS, respectively. At these higher speeds, climb cooling was adequate and the maximum mpg, glide ratio and endurance were demonstrated.

The fuel flow data was obtained using the CAFE Foundation's calibrated flow transducer.

The subjective flying qualities evaluation was flown at a c.g. located 21.5% aft of the forward c.g. limit at a takeoff weight of 2551 lb.

--Brien A. Seeley, President



### FLYING QUALITIES REPORT

EXPRESS N360EZ  
by

C. J. STEPHENS  
CAFE Foundation Test Pilot

Wheeler Express, N360EZ, was of superb construction and perfect finish. The owner, Jerry Sjostrand, had created his own personal touches in many areas. These were well thought out and constructed with very high quality materials.

During my familiarization walk around and detailed inspection of the Express I was impressed with the smooth flowing lines of the design that blend the various aerodynamic surfaces together. It had a normal, yet sleek appearance, with a moderate sweep back of the tail surfaces. There was a sturdy fixed step to aid in stepping up onto the wing walk. All placards and decals on the airplane were of exceptional quality.

### ACCOMODATIONS

One interesting feature on this design was the very large entrance door. The door is on the right side of the cabin, hinged at the top and measures 48" wide x 34" high. The two front seats were electrically operated



Jerry Sjostrand, rt., with CAFE Chief Test Pilot C.J. Stephens.

to slide forward and aft at an angle such that it raised a person with shorter legs and lowered (as it moved back) for longer legged individuals. It was a very clever and simple design adapting electric motors from an automotive application. The single control stick was located between the two front seats, a modification of the stock control system which allowed the plane to be flown from either side equally well. The throttle quadrant, however, was on the left cabin wall in a position only

available to the pilot in the left seat. The control movement felt quite comfortable and natural when operated from either seat.

One very nice and unusual feature, of the aircraft design, was the tremendous amount of leg room in the back seats. It measured 74 inches from the back of the front seats to the baggage compartment bulkhead. The owner had even built a litter type of installation that could be used with a sleeping bag giving a full 6 ft. 2 in. place for

two people to sleep, once the two back seats were removed. The amount of room available in the rear seat was reminiscent of some of the earlier airplanes such as a Stinson Station Wagon or a Beechcraft Staggerwing.

The 15" x 18" baggage door was purposely designed to be large enough to crawl through for cabin exit were the aircraft to become inverted in an accident--a very commendable idea for any light aircraft. A reliable inside door opening lever was installed to complement the flush external door lever.

## COCKPIT LAYOUT

The cockpit had a full compliment of electronic equipment with full VFR systems plus a limited IFR capability. This cockpit was laid out with all of the amenities required to make flying fun. Other cockpit features included cabin heater, defog, cowl flap and ample vents for cabin cooling air.

One item that was of concern to me was the cabin door locking system. It had a single lever to engage both of the hold down locks, but the lever was exposed to and just above the copilot's knee in such a way that, with cockpit movement or turbulence, upward motion of the knee could inadvertently open the entrance door. This could cause a sudden dangerous and destructive loss of the door on an otherwise normal flight and should be revised to prevent that possibility.

The sturdy instrument glare shield had two grasp handles cut into it for assistance with entrance and exit from the cockpit. This was a helpful feature, since cockpit entrance required stepping on the seats and maneuvering across the right seat and past the control stick before being able to slide into position.

The engine instrumentation installed, a Vision Micro Systems package, provided adequate information for all aspects of flight.

## GROUND HANDLING

When pushing backwards with the

Flight Data	Flight #/date	Clock	A/C weight	M.P.	RPM	Density alt.	CAS	TAS baro	Rate, fpm
Wheeler N360EZ	Descent mode								
	5/9.21.97	10:56:10	2850	11.2	899	7800	94	104	-641
	1/9.20.97	08:55:50	2830	7.3	1800	6000	228	251	-3180
	1/9.20.97	08:38:40	2847	6.9	1337	8000	171	194	-1552
	Climb mode								
	1/9.20.97	08:45:40	2840	23.8	2763	6800	118	130	746
	6/9.21.97	11:59:12	2426	28.2	2766	2800	115	120	1297
7/9.26.97	06:28:02	2884	27.2	2760	3000	112	118	916	

Flight data	Flight #/date/clock	A/C weight	CAS baro	TAS baro	Pres. alt.	OAT °F	Dens. alt.	M.P.	RPM	Gph	MPG	VFR endurance, hrs.	Range	Final speed, mph
Wheeler	1/9.20.97/08:32:55	2840	149.3	173.2	8493	49.0	9813	21.4	2597	9.7	18.1	9.2	1612	175.7
N360EZ	1/9.20.97/7:45:15	2885	174.8	191.6	4446	70.2	6190	25.4	2780	11.1	17.6	8.0	1564	194.7
Final Speed in mph corrected for drag due to the barograph	5/9.21.97/10:36:11	2877	168.0	189.0	5704	70.6	7747	24.1	2598	12.3	15.4	7.2	1368	189.0
	5/9.21.97/10:38:37	2874	168.3	189.5	5708	71.0	7778	24.1	2604	11.7	16.2	7.6	1442	189.5
	5/9.21.97/10:39:58	2873	168.6	189.9	5724	71.0	7798	24.1	2607	11.1	17.1	8.0	1523	189.9
	5/9.21.97/10:41:19	2871	169.8	191.2	5713	71.1	7791	24.1	2602	10.5	18.2	8.5	1621	191.2
	5/9.21.97/10:42:15	2870	168.9	190.2	5709	71.3	7794	24.1	2598	10.0	19.0	8.9	1693	190.2
	5/9.21.97/10:42:56	2869	165.9	186.8	5710	71.3	7797	24.1	2590	9.5	19.7	9.4	1750	186.8
Approx. Vy	5/9.21.97/10:48:46	2863	112.3	127.0	5784	82.1	8536	18.8	2220	5.8	21.9	15.3	1949	127.0
Approx. Vx	5/9.21.97/10:53:36	2859	90.1	101.1	5787	83.7	8635	18.0	2211	5.5	18.4	16.2	1635	101.1

provided tow bar, care was needed to prevent reverse casting of the nose wheel. Without a good grip on the tow bar, there was a strong tendency for the nosewheel to flip backwards when backing up.

Fueling of the Express was normal through a fueling port near each wing tip. The two tanks were separate and could be fed with a right/left/off valve from the cockpit to manage fuel and maintain lateral balance during flight. The latter was found to be important because the aircraft had no aileron trim mechanism.

Total capacity of the fuel system was 92 gallons. By our estimates that amount of fuel would be enough to leave Santa Rosa, California and fly nonstop to Chicago. However, since many pilots routinely takeoff with full fuel tanks for local flights, the impressive tankage of the Express tends create unnecessarily high takeoff weights producing sluggish performance.

Engine operation with the cabin door open required caution to prevent damage to the door hinges. The door was large and the propwash seemed to affect it unless it was held in a steady position manually. On warm sunny days, with the door closed, the cabin seemed to heat up rapidly due to the great window area. Once the engine was started, an electrically operated vent located centrally above the windshield helped offset the low volume of cabin airflow. Taxiing was easy with the use of differential braking. Field of view over the nose and in all directions was excellent during ground operations.

### TAKE OFF AND CLIMB

The pre-takeoff checks were conventional in every respect including the checking of an electronic ignition that had been installed in place of the right magneto. The suggested takeoff flap setting was easily obtained by depressing an aileron fully and matching the flaps to the position of that aileron. The flaps could be easily seen from the cockpit negating the requirement for a flap position indicator. Take off trim was set to the appropriate settings by the use of a light "T" showing the position of the two tabs. The electric elevator and rudder trims were operated by a hat switch mounted on the top of the stick grip and the position was reflected on the "T". It was difficult, for me, to get used to operating the rudder trim with right and left thumb motion of a switch that, on most airplanes, is used for the aileron trim.

I am always impressed at how smoothly these six cylinder engines feel when compared to the four cylinder engines. Prior to adding the power for take off I watched the ailerons and operated the stick to insure that I would find center stick position at lift-

off. This seemed especially important with the stick being in an unfamiliar position at the center of the airplane. With all of the preflight checks complete I was ready to experience flight with the Express.

### TAKEOFF IMPRESSIONS

The manifold pressure gauge came right up to indicate 30.1 inches, with an actual RPM of 2780. The acceleration was good considering the operating weight (maximum gross weight of 2895 lb) of the airplane. The Express tracked straight down the runway during acceleration to the owner's recommended takeoff speed of 65 kts on the panel (88 mph CAS) and followed with a smooth and comfortable lift off. Once safely airborne the flaps were retracted which resulted in a mild settling before re-establishing the climb.

Initially a climb at published Vy (78 kts on the panel airspeed indicator) was attempted. However, due to a low rate of climb and a steady increase in cylinder temperatures, a modified Vy was used for testing. The airplane seemed to climb much better when maintaining 95 kts IAS. During these climbs at the higher IAS the cylinder temperatures remained below the red line, provided the cowl flaps were open and the mixture was left full rich. The owner had indicated, as we confirmed, that the engine was very sensitive to any leaning and it was recommended that no leaning be accomplished below 9,000' during climbs.

### DYNAMIC STABILITY

The natural damping qualities were examined by introducing control doublers about an axis and then observing the tendency and reaction when returning to normal flight. Each axis was explored with the stick fixed and with the stick free to learn of the difference in damping quality generated from the control itself.

Pitch damping was deadbeat in both stick fixed and stick free modes, indicating a strong pitch dynamic stability. In yaw displacement, the aircraft showed low damping with both the rudder free and with the rudder fixed. It would overshoot 4-5 times before returning to steady conditions. This low directional stability was evidenced later in other flight regimes.

### MANEUVERING STABILITY

Stick forces were measured while maneuvering in both clean and flaps down configuration. During the measurements the aircraft felt stable and stick forces built up as the g force increased. All of the information gathered indicates a good handling airplane about the lateral axis. Due to a "g" meter malfunction the three g data is not available. Data collection was

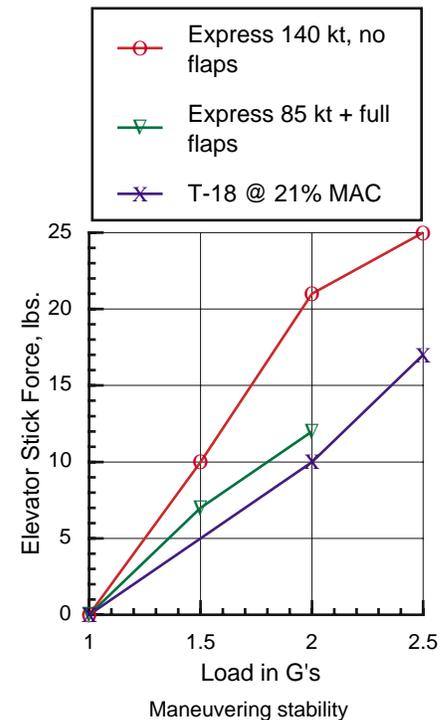
not attempted beyond three g's since the aircraft had not previously been flown to that g limit. Note the graphed results of these tests.

### SPIRAL STABILITY

Roll stability was observed by establishing a trimmed level turn of 15 degrees bank and releasing the controls. This airplane exhibited no tendency to either rollout or to increase the bank for periods of up to 30 seconds, thereby demonstrating neutral spiral stability.

### ROLL DUE TO YAW

The roll due to yaw was examined by banking to hold a heading while progressively increasing the rudder input at 120 kts panel airspeed. The airplane showed a normal amount of dihedral effect with an increasing amount of bank required as the rudder input was increased. However, near the end of the rudder input, during left rudder application, the airplane entered an uncommanded pitch down attitude without yaw recovery in spite of neutralizing the rudder. See discussion under "Problem areas".



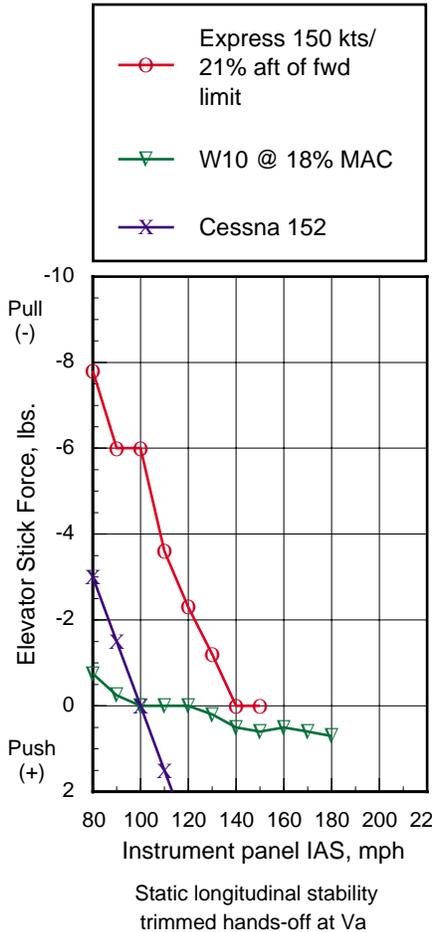
### ADVERSE YAW

Adverse yaw was sampled by observing the heading hesitation (or initial reversal) upon input of aileron without any coordinating rudder input (feet on the floor). The Wheeler tended to yaw opposite to the aileron input by 15 degrees with the right aileron

depressed and only 2 degrees with the left aileron depressed.

### STATIC LONGITUDINAL STABILITY

At 7,500 ft altitude the airplane was trimmed to "hands off" at 150 kts. Without retrimming, measurements were taken of the stick force required to hold level flight at each 10 kt increment of all attainable airspeeds. The



graph shows the results of these samples.

### ROLL RATES/FORCES

ROLL RATE, degrees/second, includes input time		
Speed, IAS	Va	1.3 Vso
RV-6A	80	36
Tailwind W10	47	45
Cessna 152	47	34
Express	39 Rt./55 Lt	29 Rt./50 Lt

The roll rate and stick forces were measured using the handheld stick force gauge in flight and a stop watch during replay of the video tape. At 140 kts the stick force measured 25 lbs to attain full deflection. Generally the feel of the stick forces was very comfortable and normal, although at above 150 kts IAS the ailerons became noticeably harder to deflect. The roll rates shown below include the time to accelerate, rather than the sustained roll rate. Full aileron deflection was used to establish the roll and maintained during the 120 degrees change in bank angle.

### STALLS

The stall characteristics of the airplane were sampled at various gross weights, c.g.'s, and flap settings. The stall was preceded by noticeable aerodynamic buffet occurring at 5-7 kts

Flight Data	Config.	A/C Weight, lb	CAS, mph
Express			
N360EZ	Clean	2865	77.2
stall	Dirty	2863	67.2

Panel IAS, kts/mph	Cabin Barograph, mph	CAS, mph
63/75.58	71.50	86.32
71/81.79	80.79	91.85
80/92.16	91.82	100.16
87/100.22	98.68	105.67
95/109.44	108.27	113.59
100.5/115.78	115.40	119.12
107/123.26	123.51	125.25
115/132.48	130.90	132.25
120/138.24	137.75	137.30
130/149.76	148.59	147.05
139/160.12	160.51	156.58
145/167.04	167.34	162.51
152/175.10	174.76	170.26

N360EZ  
Airspeed Calibration

above the actual stall. When the stall occurred the airplane would simply lose lift and allow the nose to drop slowly just prior to the stick being nearly full aft. Following 1 g level clean stalls the airplane would produce an uncommanded right yaw with inadequate elevator control until significant airspeed (85 kts panel) had been regained.

A very nice electrically operated speed brake similar to that used on Mooney's was installed in the top of the wing at about mid-span and mid-chord. A panel mounted on/off switch was used to activate the speed brake to the fully out or fully retracted position. It was effective and could be activated at any airspeed without causing any noticeable pitch change. From stable, trimmed level flight at 130 kts, the speed brake deployment would produce a 400 fpm rate of descent. That is an expression of the drag from the speed brake alone since all other energy values were held constant. Stalls with the speed brakes deployed were uneventful and occurred at virtually the same airspeeds as without the brakes.

### TRAFFIC PATTERNS/LANDINGS

The Wheeler handled nicely in coordinated flight in the traffic pattern with a very low work load for the pilot. The simple cockpit layout, fixed landing gear, and excellent engine system left the pilot free to deal with other traffic, pattern management, and radio communications. The field of view during letdown and turns was also very good. On flaring, touchdown and control were comfortable and straight forward using both the flaps up and flaps down configurations.

### CONCLUSIONS

The Express has an outstanding appearance with sleek, modernistic lines. In my opinion, the development of its handling qualities needs to be continued as outlined above to



N360EZ's cabin had a flat floor covering 2 storage bays and could be used as a 74" long bed. A 4th seat could be installed as an alternative.

Brian Sealey

## ABOUT THE OWNER

Jerry Sjostrand was born in Montana and moved to the San Francisco area of California just before World War II. He raised five children and hosted several foreign exchange students. He had long been a skilled craftsman, having been a teacher of industrial arts for several years. He began flying Luscombes at Torrance Airport, trading paint jobs for flight time. He soon rented a Cessna 172 and 2 weeks later bought it.

Jerry obtained an instrument license and accumulated 3500 hours flying time, all in general aviation. He founded and grew a business which manufactures power sanding backing pads and discs and also now operates a sign-making company in Oakhurst, California. With the company's success, he began a run of buying a new Cessna 182 about every 3 years. He owned 2 Cessna Turbo 206's along the way. When Cessna quit building singles, Jerry began looking around for a suitable alternative.

He closely followed Ken Wheeler's Express development for 2 years before buying his kit. When the Express development was imperiled by the crash of the second prototype, Jerry spent 5 weeks in Washington providing major assistance to Ken and Gail Wheeler in building a new Express factory demonstrator, building production parts and organizing many of the early drawings and plans into a usable format to help the company succeed.

The Sjostrand family has hosted many foreign exchange students, each for at least one year. The students have visited from Brazil, Peru, Sri Lanka, Japan, Sweden, Finland and Germany. The Sjostrand family maintains friendly ties with these students. Through them, Jerry has opportunities to visit abroad and help Express builders outside the United States.

Jerry sums up his airplane views thusly: "I built the Express for the experience of building it, not just to have an airplane. I could have bought an airplane. I'm interested in being with people who are dedicated, interested, and love aviation—that's where I'm comfortable. I like to teach. I've held seminars in Oakhurst for Express builders. In the future, I will be helping others to build their Express, as I've done in the past. I do not plan to build any other aircraft."

When asked if he wanted his Wheeler to be tested by the CAFE Foundation, Jerry was immediately enthusiastic. He participated actively in the test preparation process and worked diligently with the CAFE team throughout the testing process. His aircraft served as a showcase for the CAFE test equipment during the Cessna Aircraft Corporation's visit to the CAFE Foundation 1 week later.

## EXPRESS, N360EZ

**Estimated Cost: \$ 115,000 total cost including materials, engine, prop, interior, instruments and radios.**

**Hours to build: 5000**

**Completion date: September 1995**

### SPECIFICATIONS, EXPRESS N360EZ

Empty weight, gross wt.	1994.1 lb/2895 lb with oil
Payload, full fuel	348.9 lb
Useful load	900.9 lb
ENGINE:	piston, 6 cylinder opposed, direct drive
Engine make, model	Continental IO-360 ES1B
Engine horsepower	210 BHP
Engine TBO	2000 hr
Engine RPM, maximum	2800 RPM
Man. Pressure, maximum	29.5 in Hg
Turbine inlet, maximum	na
Cyl head temp., maximum	460° F
Oil pressure range	30-60 psi, 115 psi on startup
Oil temp., maximum	240° F
Fuel pressure range, pump inlet	12-28 psi
Weight of prop/spinner/crank	na
Induction system	Continental Motors fuel injection
Induction inlet area	off cooling inlets
Exhaust system	ss, 3 into 1 each side, 2" outlets
Oil capacity, type	8 qt. 15W-50
Ignition system	Slick mag lt., Lightspeed CD electronic rt.
Cooling system	2 pitot inlets, downdraft
Cooling inlet area	47.5 sq in (stock cowl)
Cooling outlet area	35 sq in, fixed with cowl flap full open
PROPELLER:	constant speed
Make	Hartzell PHC-C3YF-1RF/F7663-4R
Material	aluminum
Diameter	71.5 in, 3 blades
Prop extension, length	none
Prop ground clearance, full fuel	9 in
Spinner diameter	14.5 in
Electrical system	alternator 14V
Fuel system	1 tank in each wing, electric boost pump
Fuel type	100 or 100LL octane
Fuel capacity, by CAFE scales	na
Fuel unusable	2 gal
Braking system	Matco dual cylinder
Flight control system	elevator + rudder by cable, aileron by push pull tube
Hydraulic system	na
Tire size, main/tail	6.00 x 6 mains/5.00 x 5 nosewheel
CABIN DIMENSIONS:	
Seats	4
Cabin entry	48 x 34 inch gull wing door rt. side
Width at hips	43 in
Width at shoulders	44 in
Height, front seat to headliner	varies with seat position
Baggage capacity, rear cabin	33W x 28H x 24L in, 74L in litter available
Baggage door size	15 x 18 in opening above seatback
Lift over height to baggage area	43 in
Step-up height to wing T.E.	17 in to step + 10 in to wing T.E.
Approved maneuvers:	non-aerobatic cross country use; no spins or inverted flight.
CENTER OF GRAVITY:	See table

**PROBLEM AREAS:**

Several times during my experience with the Wheeler in flight, the plane exhibited characteristics that should be further investigated by a qualified person, employed by its kit manufacturer, with the idea of design improvement. These areas are listed below:

**LOW DIRECTIONAL STABILITY**

The cruciform tail (mid-mounted horizontal stabilizer), wide tapering fuselage, and highly swept vertical stabilizer combine to produce low yaw stability. This was evident during dynamic testing, high angles of attack, and during excursions into high yaw situations at one g. An uncommanded right yaw with inadequate elevator control occurred after 1 g clean stalls and persisted until airspeed over 85 kts had been regained. This behavior should receive more investigation by a professional test pilot wearing a parachute.

While holding constant heading in uncoordinated flight at 120 kts panel airspeed, the nose would gradually pitch down as more yaw was introduced. Before the limits of the rudder were reached the elevator authority became insufficient to hold a level attitude. The airplane would stay highly yawed regardless of the rudder position commanded by the pilot as the nose increasingly pitched down. Once the airspeed increased to about 130 kts the airplane could be returned to controlled straight and level flight.

**EXCESSIVE RUDDER TRAVEL**

The rudder, as tested, was set to allow up to 26 degrees deflection per the construction manual. Use of this large amount of deflection, when combined with the low yaw damping, seemed to set up a partial stall of the

vertical fin, further compounding the yaw instability. Interview with the owner indicated that some prior testing of this had been done with a video camera and tufts and those tests had confirmed poor airflow over significant portions or the vertical tail. The construction manual allows that the rudder deflection can be set as low as 20 degrees maximum deflection. From my observations this would seem to me to be a more desirable setting.

**BLANKING OF HORIZONTAL TAIL**

The tail power seemed to be adequate for most regimes of flight, however, during post stall and high yaw maneuvering the horizontal/elevators seemed to have inadequate effect. This seemed to be caused by blanking of the horizontal tail and elevators by the vertical stabilizer at the highly yawed condition. More testing is definitely in order to study the flow field around the tail in this situation and to develop improved tail effectiveness.

**STATIC PORT ERRORS**

Considerable position error was evidenced in the Wheeler's pitot-static system. The panel indicator read over 14 kts below CAS at the minimum airspeeds recorded and was about 5 kts optimistic at high cruise speeds.

The pitot-static tube was mounted under the wing 90° to the usual stand-off strut fitting. The static ports were located on the top and bottom of the wall of the pitot tube. Any angle of attack change (even that due to turbulence) caused large fluctuations within the instruments that were connected to this static port. Simply pulsing the stick caused deflection of instruments proportional to the amount of stick deflection. This is a simple item to fix.

**FURTHER TESTING**

The owner, Jerry Sjostrand, returned to the CAFE Foundation test facility nearly one month following completion of our tests on his airplane to further study the problems in stability that were discussed here. He had, since the original visit, reduced the amount of rudder travel from 26 degree deflection to 20 degrees deflection. This lower setting was allowed in the basic construction manual. Jerry had requested that I re-evaluate the handling qualities with this lower rudder deflection and report any changes this had produced.

There was definite improvement with the lower rudder deflection limits. All of the original characteristics were exhibited again but to a lesser degree. As with the previous testing in level, fixed heading, uncoordinated flight, the nose position would drop increasingly as the rudder input was increased beyond 2/3 deflection. This tendency could now be adequately countered with aft stick to hold the nose up. Prior to resetting the rudder to the lower stop position the airplane would simply run out of up elevator in this condition. The elevator was now sufficient to hold the nose in level flight even with full rudder deflections.

I feel that the main cause of this tendency is that the vertical fin is blanking the horizontal tail as the yaw is increased. The loss of force is compensated by increased elevator input as the yaw is increased, however, with the higher rudder travel the yaw reached a point that the plane ran out of elevator, leaving the airplane in a nose down attitude. Reducing the rudder simply limits the blanking of the vertical stabilizer by not allowing the high yaw angles.

--C.J. Stephens, Chief Test Pilot

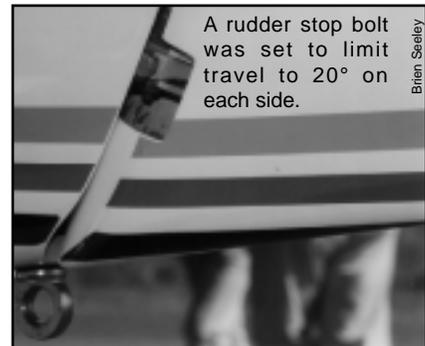
fully realize the design's potential and insure a safe and predictable airplane.

The quality of construction of

N360EZ was absolutely superb. Every feature was well thought out and built to excellent standards. Jerry Sjostrand

has every reason to be proud of his airplane. The finish quality and attention to detail were among the best of any aircraft that the CAFE Foundation has had the pleasure of testing.

SAMPLE C.G. CALCULATIONS, Express N360EZ							
Aft sample item	Weight	Arm	Moment	Empty weight c.g.	Weight	Arm	Moment
Main gear	2440.0	93.2	227376.3	Main gear	1553.2	93.2	144738.0
Nose gear	469.0	15.8	7386.8	Nose gear	440.9	15.8	6944.2
Pilot	incl	76.9		Pilot	0.0	76.9	0.0
Passenger, rear	incl	122.0		Passenger	0.0	122.0	0.0
Fuel, wing tank	incl	80.1		Fuel, wing tank	0.0	80.1	0.0
Oil, 7 qt. included	incl	36.5		Oil, 7 qt. included	0.0	36.5	0.0
Baggage	none	132.2		Baggage	0.0	132.2	0.0
TOTALS	2909.0		234763.0	TOTALS	1994.1		151682.2
Gross weight	2895.0	92.0	gal. in wing	Gross weight	2895.0		
Empty weight	1994.1	Useful =	900.9 lb	Empty weight	1994.1		
Datum used is		Payload =	348.9 lb				
34' fwd of firewall aft							
Empty weight c.g.	76.07			Empty weight c.g.	76.07		
c.g. range, inches	76.25-82.0			c.g. range, in	76.25-82.0		
c.g. range, % MAC	na			c.g. range, % MAC	na		
c.g. in inches	80.7			c.g. in inches	76.1		



A rudder stop bolt was set to limit travel to 20° on each side.

Brian Seeley

## KIT SUPPLIER

Express Aircraft Company  
7825 Old Highway 99 S.E.  
Olympia, WA. 98501  
360-352-3554 W www.express-aircraft.com

## OWNER/BUILDER N360EZ

Jerry Sjostrand EAA# 278257  
40278 Oak Park Way  
Oakhurst, CA. 93644.  
209-683-5918 H pager= 209-658-4215

## DESIGNER'S INFORMATION

Cost of kit, no engine, prop, avionics, paint	\$34,995
Plans sold to date	300
Number completed	30
Estimated hours to build, from prefab kits	2000 hr
Prototype first flew, date	1987
Normal empty weight	1850 lb
Design gross weight	2895 lb
Recommended engine(s)	Cont. IO-360 ES1B, Lyc. IO-540 C4B5

Advice to builders:

Build it light and per factory manual, communicate with builders & factory.

## CAFE FOUNDATION DATA, N360EZ

Wingspan	31 ft
Wing chord, root/tip	60 in/ 37.5 in
Wing area	130.29 sq ft
Wing loading	22.2 lb/sq ft
Power loading	13.8 lb/hp
Span loading	93.4 lb/ft
Airfoil, main wing	NLF 0215F
Airfoil, design lift coefficient	0.2
Airfoil, thickness to chord ratio	15%
Aspect ratio, span <sup>2</sup> / sq ft wing area	7.4
Wing incidence	+1.5°
Thrust line incidence, crankshaft	1.5° rt, 0° down
Wing dihedral	5° bottom, 4° top
Wing taper ratio, root/tip, long wing	37.5 in/60 in = 0.63
Wing twist or washout	0°
Wing sweep	spar perpendicular to fuselage
Steering	differential braking, castoring nosewheel
Landing gear	fixed, with wheel pants
Horizontal stab: span/area	112 in/13.14 sq ft, NACA 66-009
Horizontal stabilator chord, root/tip	25/8.5 in
Elevator: total span/area	120 in/ 8.63 sq ft
Elevator chord: root/tip	11.5/11.5 in
Vertical stabilizer: span/area incl. rudder	na, symmetric section
Vertical stabilizer chord: average	na
Rudder: average span/area	52 in 4.33 sq ft
Rudder chord: bottom/ top	12/12 in
Ailerons: span/average chord, each	54 in/8.88 in
Flaps: span/chord, each	89.7/10.5 in
Tail incidence	-0.8 °
Total length	25 ft 8 in
Height, static with full fuel	84 in
Minimum turning circle	na
Main gear track	135 in
Wheelbase, nosewheel to main gear	see Sample c.g.'s
Acceleration Limit Loads	+6 and -4 g.
AIRSPEEDS PUBLISHED BY SUPPLIER*	
Never exceed, V <sub>ne</sub>	230/265 kt/mph
Maneuvering, V <sub>a</sub>	153/176 kt/ mph
Best rate of climb, V <sub>y</sub>	70/81 kt/ mph
Best angle of climb, V <sub>x</sub>	59/68 kt/mph
Stall, clean, V <sub>s1</sub>	58/66.8 kt/mph
Stall, dirty, V <sub>so</sub>	55/63.4 kt/mph
Flap Speed, full 40°, V <sub>f</sub>	120/138 kt/mph
Gear operation/extended, V <sub>ge</sub>	na

\* From Express Aircraft Co. LLC

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## COMPARATIVE AIRCRAFT FLIGHT EFFICIENCY, INC. The CAFE Foundation:

A Non Profit, All Volunteer, Tax-exempt Educational Foundation  
4370 Raymonde Way, Santa Rosa, CA. 95404.  
FAX 544-2734.

Aircraft Performance Evaluation Center:  
707-545-CAFE (hangar, message)

America Online: CAFE400@aol.com



Cowl exits include 2" exhaust pipes and electric cowl flaps.

Brian Seeley



CAFE flight test displays were taped to the panel.

Jo Dempsey

#### CAFE HONORARY ALUMNI

Steve Barnard--RV-6A  
Jim Clement--Wittman Tailwind  
Jim Lewis--Mustang II  
Ken Brock--Thorp T-18  
Larry Black--Falco F.8L  
Chuck Hautamaki--Glasair III  
Jeff Acklund--Legend  
Jerry Sjostrand--Express