QUICKIE-TYPE AIRCRAFT DESIGN ORIGINS

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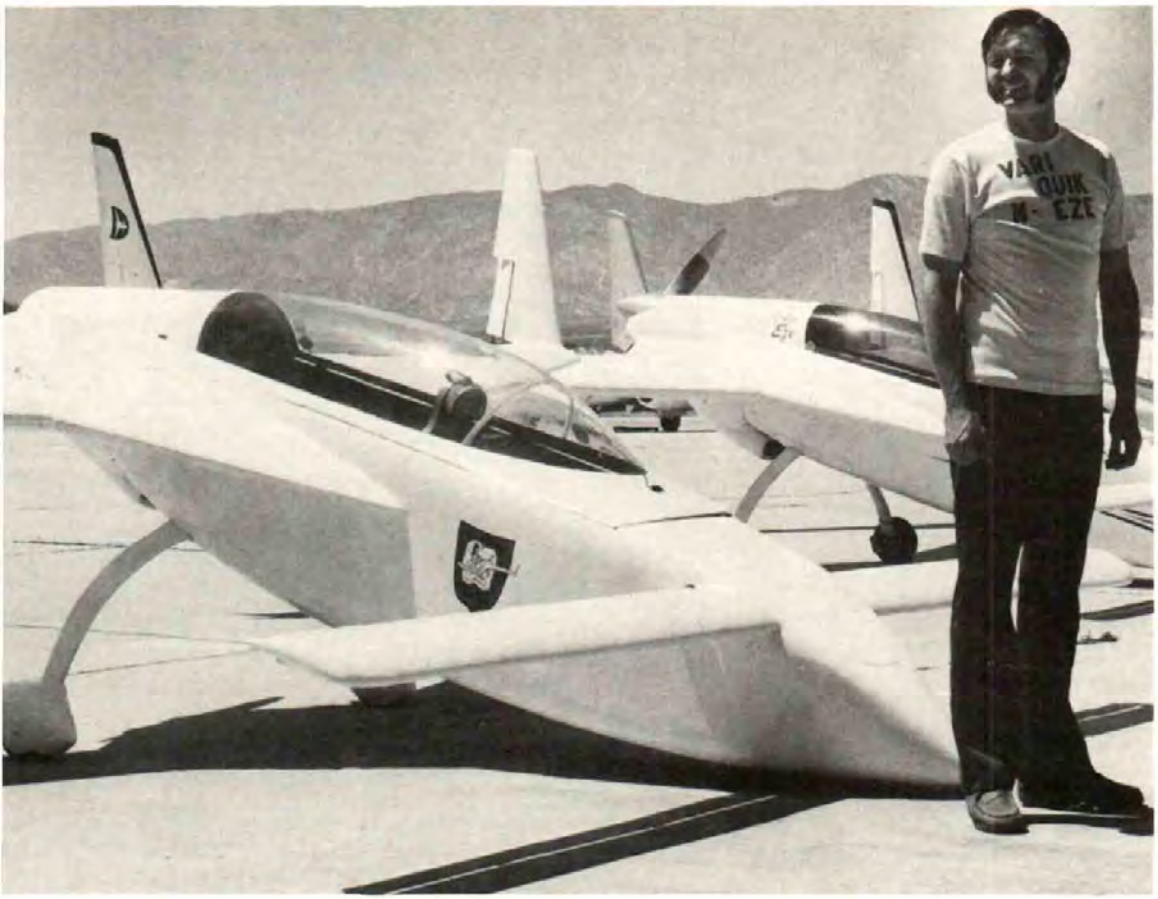


(Photo Courtesy Rutan Aircraft)
Burt with N7EZ and N4EZ.

THERE IS CURRENTLY a lot of confusion about the design origins of the recent crop of new tandem wing aircraft developed over the last several years. The confusion is the result of my silence on the subject and the various claims and confrontations of some of the other participants. In order to clear the air on the subject I am publishing the following facts. My hope is to invite the other developers to work together in an environment of constructive cooperation to assure the development of safe, efficient tandem wing aircraft and to continue their deserved reputation of excellent flying qualities and no-compromise safety.

Quickie Origin

In the spring of 1977 Gene Sheehan, who had been evaluating several small powerplants, and Tom Jewett, then a Rockwell employee, proposed to me that I design a scaled-down single-place VariEze that would have structure light enough and aerodynamics efficient enough to allow adequate performance with the Onan engine (16 to 20 hp and 80 lbs.). The original sketch I made of that configuration is reproduced in Figure 1 ("Model 49") sketch, complete with the results of my initial performance calculations. While the Model 49 appeared feasible, it had potential shortcomings: very low Reynolds number on the fins and canard wing and excessive CG travel with pilot weight variation.

Over the next several weeks I sketched and then ran preliminary aerodynamic calculations on several configurations which could use the Onan engine. One of them, the Model 54, solved the problems of the Model 49, offered potential for stall resistance, and had simi-

lar performance. The original sketch of the Model 54, which was refined to the Quickie, is reproduced in Figure 2 ("Model 54") sketch. It was first called the "X-Fighter" after seeing the then-new film **Star Wars** (note resemblance with front view). It was later called Quickie, the name I had previously reserved for my RAF Model 44, a quick-to-build minimum-manhour-construction airplane designed in 1975.

While I was proud of the potential of the Quickie design, the summer of '77 found me very busy with the expanding VariEze homebuilt program and the initial development of the Defiant twin. Thus, I did not want to expand into a large kit business to market Quickie. Gene and Tom did, however, so we worked out an agreement where I would fund, develop and test the Quickie at RAF. Then, after testing was completed (design freeze), I would turn the entire program over to Gene and Tom, they paying me for the development out of future sales of Quickie and future Quickie related designs.

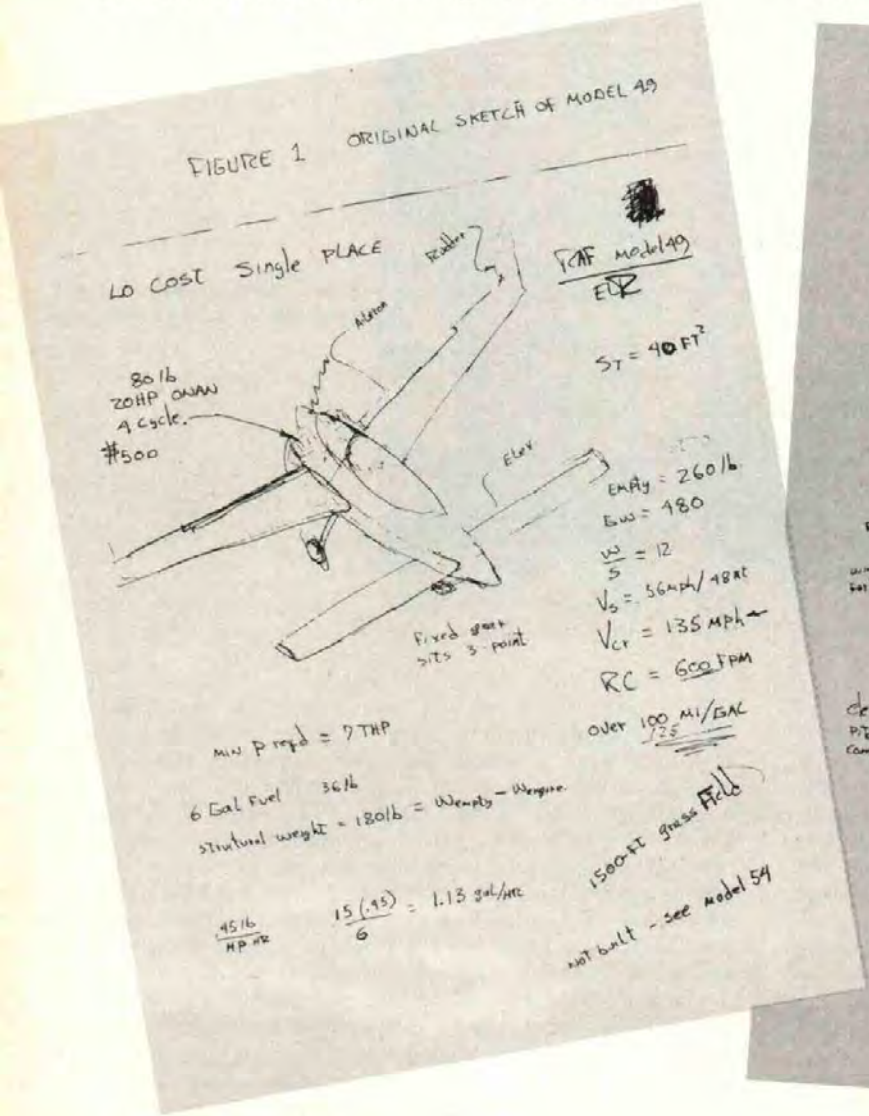
Gene worked with me full time and did all the firewall-forward (engine installation) design and development. After the aircraft was flying, Tom joined us full time and converted the shop drawings to the format for printing the Quickie plans.

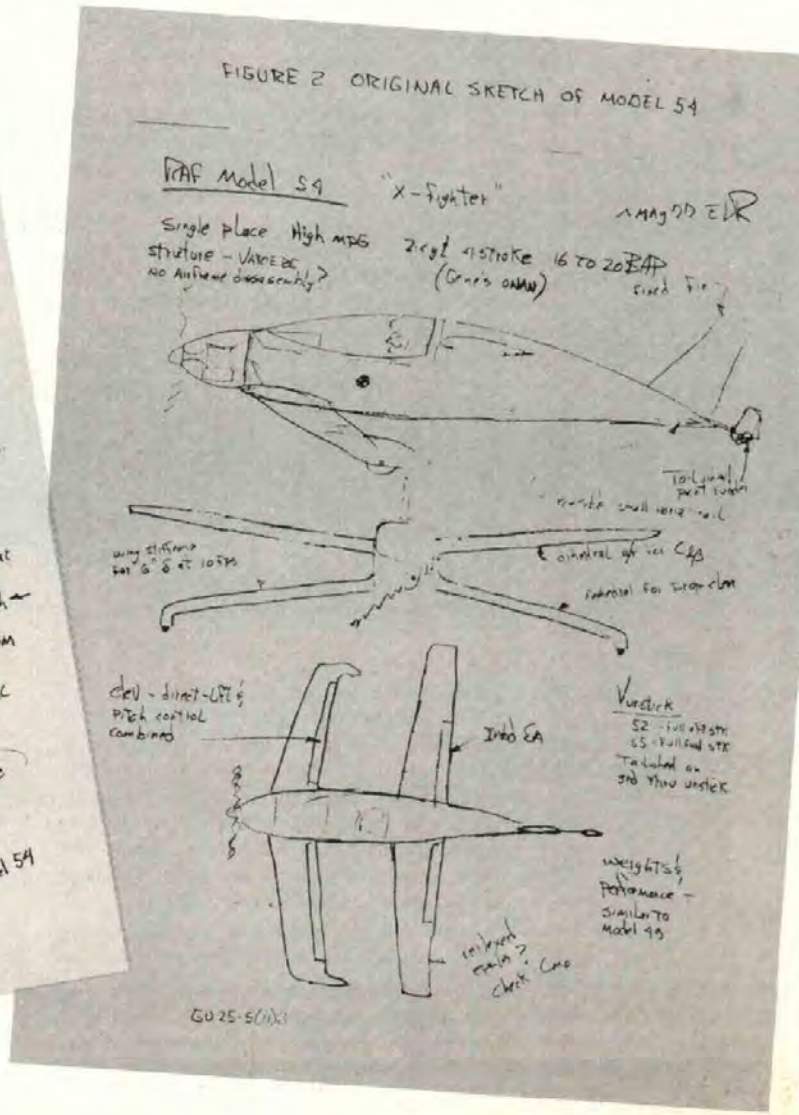
The Quickie prototype, N77Q, flew reasonably well on its initial test flights in November 1977. It did, however, have several deficiencies that required aerodynamic rework, including a new canard configuration as well as airfoil and span changes on the aft wing.

By early spring of 1978, we were all satisfied with the flying qualities and had the entire test envelope completed. The Quickie effort then left the RAF facility and has since been run as a complete-kit concept by Gene and Tom without any active participation on my part. I have not had any authority or association with the Quickie Aircraft Corporation regarding their marketing, builder support or any other aspect of their business.

History

The tractor tandem-canard/vertical-fin-on-fuselage configuration is not one I "invented" for the Quickie, as it has been used on experimental aircraft since the twenties and in larger numbers during the fifties in France. I'm not a good aviation historian, but when a design is introduced it generally prompts many old timers to send me their old photos and drawings, proving that there are really very few truly "new" designs. For example, Jack Cox found a design from a 1912 aviation journal that had been wind tunnel tested and was reputed to be stall proof. This Drzewiecki-designed airplane was the same general configuration as the original VariEze, down to the one-way rudders and loaded canard with elevons (see Figure 3). One wonders in what direction aviation development might have veered had this airplane been built and flown. This 1912 design appears to have performance and flying qualities much better and safer than the conventional and canard air-





(Photo by Jack Cox)

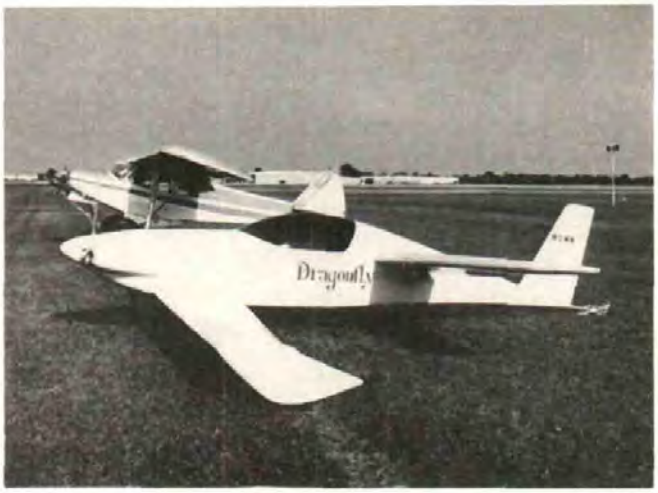
The P.A.T.-1, or "Pugmobile" as many like to call it.

(Photo by Ted Koston)

The Q2.

(Photo by Jack Cox)

The Quickie.



(Photo by Jack Cox)

The Viking Dragonfly.

craft of that day. It would be an interesting historical exercise to dig up the drawings, get a group of EAA enthusiasts together and to build and fly the 1912 Drzewiecki design. It would be well suited to the present day ultralight engines.

Dragonfly

Bob Walters, a 36 year old aeronautical engineer and Navy fighter pilot from San Diego, was a charter member of the "composite revolution", joining others who began building VariEzes in 1976. The EZ he built (N3AX) is one of the nicest ones around. He and lawyer friend Al Nelson were interested in low-power, high efficiency aerodynamics and thus were attracted to the Quickie. When suggestions made to Quickie Aircraft to scale the Quickie up to a 2-place VW powered configuration were met with objections, they decided to do it themselves. With Bob's aeronautical engineering background, Al's experience in shaping custom surfboards and a set of Quickie plans, they went to work.

Their result, first flown in June 1980, was a beautifully built prototype, N5WN. It was flown to the 1980 Oshkosh Convention and won the Outstanding New Design Award. It is a relatively low wing loading configuration with nearly 100 square feet of wing area, a conservative approach to handle the inevitable weight growths that occur with homebuilts. It uses either the small 1600cc VW engine or the mid-displacement 1700 or 1834cc, apparently producing satisfactory performance (approximately 130 knots) on 47 to 62 horsepower, with a gross weight of 1075 lbs. I was not involved in the design or test effort of the Dragonfly.

I have not yet flown the Dragonfly. Thus, I cannot comment on the state of its development, the adequacy of its flying qualities, difficulty of piloting or performance. It initially had a trim authority/speed stability problem due to a large difference between its trim elevator position and float elevator position. This was presumably solved by adding the external-boom trim tabs we developed for the VariViggen.

The Dragonfly is marketed similarly to our Long-EZ in that Bob sells plans and builders obtain materials from either manufacturers or distributors.

Q2

Unknown to Bob Walters (and vice versa), Garry LeGare, a Canadian pilot businessman and homebuilt parts supplier, also wanted to scale the Quickie up to two-place and VW power. Garry had a business relationship with Quickie Aircraft Corporation as the dealer for the Quickie kits in Canada. Upon asking, Garry found that Gene and Tom were indeed interested in a two-place and had already done some preliminary sketches. They arrived at an agreement where Garry would develop and build the prototype in Canada and they would all be involved in its testing. Quickie would

then market the kit and reimburse Garry from sales. Armed with the Quickie design and some additional design information from Gene and Tom, Garry set out in late 1979 to design and build the prototype Q2. Garry flew the first flight in July 1980. It was originally registered in Canada and later registered as N8490P after it was brought to Mojave for testing in the fall of 1980. I was not involved in the design or test effort of the Q2 in any way. Quickie Corporation redesigned the fuselage to a molded-shell configuration and built their own Q2 (N81QA) in early 1981. The Q2 prototype was damaged in an accident caused by propeller failure and Garry salvaged the aft wing to build a new Q2. It used the new fuselage design. Both these aircraft appeared at the 1981 Oshkosh Convention.

I have not yet flown the Q2. Thus, I cannot comment on the state of its development, the adequacy of its flying qualities or difficulty of piloting. I would like very much to fly a Dragonfly or a Q2 and offer a Long-EZ checkout to anyone who completes their airplane and would like to trade rides!

Comparisons

Despite their similar appearance, the Q2 is in a different class than the Dragonfly. Its engine is larger and its wing area is only about 2/3 that of the Dragonfly. Thus, it was aimed more at high speed cruise.

Few people remember my original concept for the VariEze since it has now been over six years since the May '75 first flight date of N7EZ, a small, light, VW-powered prototype. Only one of these aircraft was ever built. N7EZ now resides in the EAA Air Museum after logging 480 hours divided between three different VW-conversions and a Franklin two-cylinder. N7EZ was flown by over 30 different pilots and set a world's distance record.

The adjacent table shows that N7EZ and Q2 were in the same class, with nearly identical power loading and wing loading.

It was a very difficult decision that I made in 1975 to **not** market plans for the N7EZ type airplane. I was obviously proud of the performance and efficiency. However, I was concerned that it was too small, i.e., too "hot" and sensitive for the average pilot on initial checkouts. I was also concerned about the safety of using a non-aircraft engine with the approach speeds as high as they were. Thus, I scaled the airplane up in size to accept the Continental 0-200 aircraft engine. This raised the empty weight by 160 lbs. and made a larger, more solid flying airplane. The change required me to build and test a new prototype (N4EZ) and delayed introduction of the VariEze plans until mid-1976. Even though scaling the airplane up reduced the fuel efficiency, the net result was lower cost, since the aircraft engine has been trouble-free for its entire 520+ hours and has cost considerably less than the four engines did in N7EZ. During 1979/1980 the VariEze was further scaled up, adding 46% more wing area and increasing empty weight another 160 lbs. This aircraft (the Long-EZ) was designed for the excellent Lycoming 0-235 engine. The Long-EZ (prototype is N79RA) has greatly increased utility and improved flying qualities. It has now virtually replaced the VariEze.

P.A.T.-1

The Piper Advanced Technology P.A.T.-1, known affectionately as the "Pugmobile", was designed by George Mead in late summer 1980. The late Howard (Pug) Piper, son of the founder of Piper Aircraft, had contracted with George to develop a four-place prototype aircraft of all-composite construction, that might lead to a production aircraft.

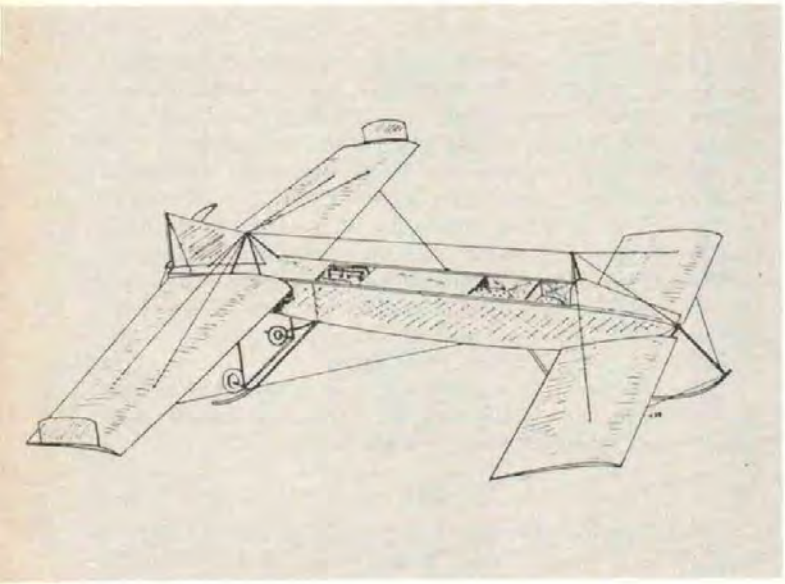


Fig. 3 Canard/Tandem Design from 1912.
The Drzewiecki Monoplane.

(Photo Courtesy RAF)

This aircraft is currently keeping folks busy around the Rutan Aircraft Factory in Mojave. It's a 62% scale version of the Fairchild Republic entry in the competition to replace or modernize the T-37 military trainer. Burt Rutan was commissioned to design a scaled-down, all composite version that could be used to obtain flight test data quickly and more economically than conventional wind tunnel/prototype programs. The airframe was built by the Ames Industrial Corporation, which also provided the two TRS-18-046 turbo jet engines. Rutan Aircraft got the flight test contract and Dick Rutan made the initial flight on September 10. Dick, Burt, Mike Melvill and Fairchild Republic pilot, Wendy Shawler, are doing the flying. This program is similar to the one Burt did for NASA involving the swing-wing AD-1. Industry and NASA have apparently found Burt can provide more info for their buck than traditional methods . . . and in a fraction of the time.

George has been associated with EAA aircraft since 1972 when he was a BD-4 co-builder. In October 1975 I hired George to assist me in building the second VariEze (N4EZ) and to help draw the plans for printing. George also assisted me in drafting the drawings for the AD-1, the composite skew-wing jet I designed for NASA. George left RAF in June 1977, about the time I was formulating the design of the Defiant twin. In addition to his composite experience at RAF, George built a conventional single place aircraft called the Adventure, using VariEze construction techniques and materials.

For Mr. Piper's project, George selected a tractor engine, tandem-wing canard configuration. Materials and construction techniques were similar to my designs, however, I was **not** involved nor consulted during the design and development of the P.A.T.-1. After it was completed and before the flight tests, George asked me to study the design to verify his calculations. I ran the configuration through my computer programs to predict neutral point, stall speeds, stall characteristics, CG range, airload distribution and basic stability and control characteristics. That was the extent of my direct involvement with P.A.T.-1. I have not yet flown this airplane, but hope to soon.

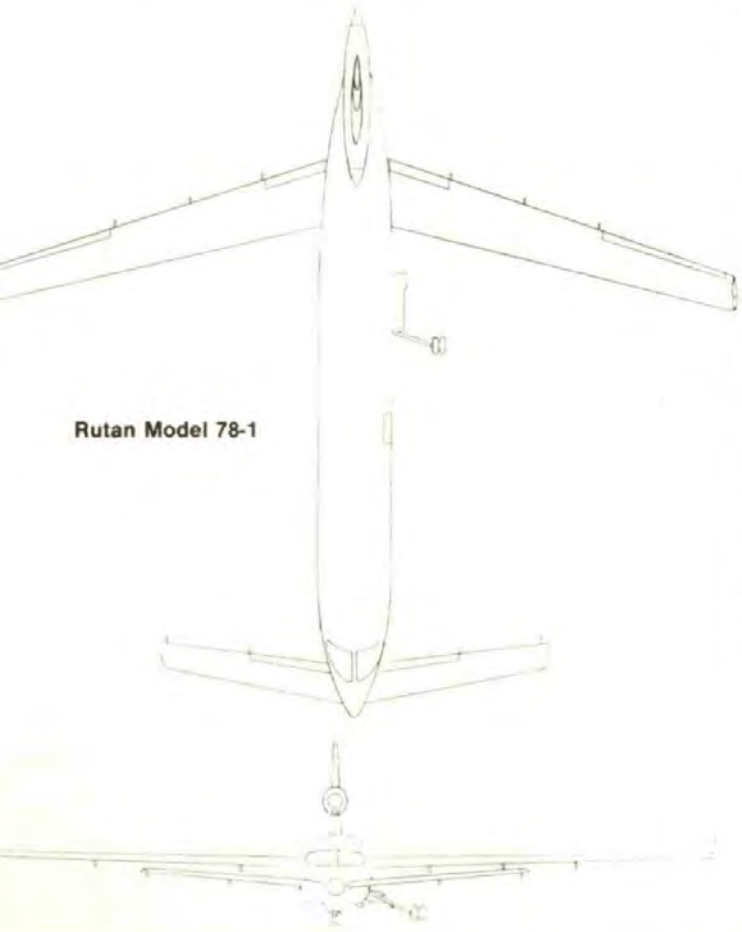
Design Flexibility, Not Guarantee

Use of the canard configuration does **not** assure good performance, stability or stall characteristics. Separating two lifting wing systems fore-aft merely gives the designer more **flexibility** in being able to tailor the stability of the configuration and the induced drag. We design the stability to be very non-linear, with a large aft-shift in the neutral point as angle-of-attack increases above a max. useable value. This is not something that happens automatically — for example, the Curtiss Ascender had the opposite effect, with the result being dangerous departures in pitch attitude at the stall.

The canard tandem wing aircraft, particularly those like the Quickie with approximately equal load carried on each wing system, are very sensitive to minor airfoil changes. The boundary-layer transition and separation patterns that are altered by minor variances in contour, incidence and even flying in rain, can have major effects on pitch stability, trim and speed stability. The aeroelastic effects (airframe twisting and bending with speed and angle-of-attack) which are normally negligible in a conventional aircraft can change a stable airframe to dangerous instability at high speeds. Conversely, aeroelastic effects can aid high speed stability with proper structural and aerodynamic design.

I have used the Quickie configuration concept in the design of nine aircraft since 1977. These have ranged from ultralights and sailplanes to agricultural planes and 32-passenger commuter airliners (for NASA). My Model 68, the Amsoil racing biplane, uses a very small horizontal tail, geared to optimize canard camber automatically for both the straightaways and 5-G turns.

The designers' data base for these types of designs is extremely limited, and the importance of understanding their aerodynamics is great. A strong possibility exists for the introduction of inferior designs that do not meet all the requirements for satisfactory flying qualities and safety and thus give the **configuration** a bad reputation. I am proud of the potential promised by this configuration to improve aviation safety and efficiency. Thus, I encourage other developers to not accept less than perfection in their aircraft that are offered to the public. I am willing to assist in solving aerodynamic or aeroelastic problems during your flight test programs if you are willing to incorporate the indicated fixes. Let's work together for better aircraft, rather than separately in a relative vacuum.



Rutan Model 78-1

Comparison
VariEze Prototype (1975) and Q2

	VariEze N7EZ	Q2 N81QA
Empty Weight	430 lbs.	530 lbs.
Useful Load	450 lbs.	470 lbs.
Gross Weight	880 lbs.	1000 lbs.
Span	22.3'	16.6'
Wing Area	61 Sq. Ft.	67 Sq. Ft.
Wing Loading	14.4 lbs./ft.	14.9 lbs./ft.
Power Loading	14.2 lbs./hp	14.2 lbs./hp
Fuel	20 gals.	20 gals.
Take-Off	700 ft.	620 ft.
Landing	1100 ft.	1400 ft.
S/L Rate of Climb	1200 ft./min.	1200 ft./min.
75% Cruise	158 kt.	151 kt.
Range at 75%	820 nm	800 nm
N/M Gal. at 75%	41	40
Max. NM/Gal.	58	53
Stall Speed	56 kt.	56 kt.
Engine	1834cc VW	Rev. 2100cc
Horsepower	62	70.5
Max. Crew Size	Two 6'4"	Two 6'5"

All performance values are at gross weight.