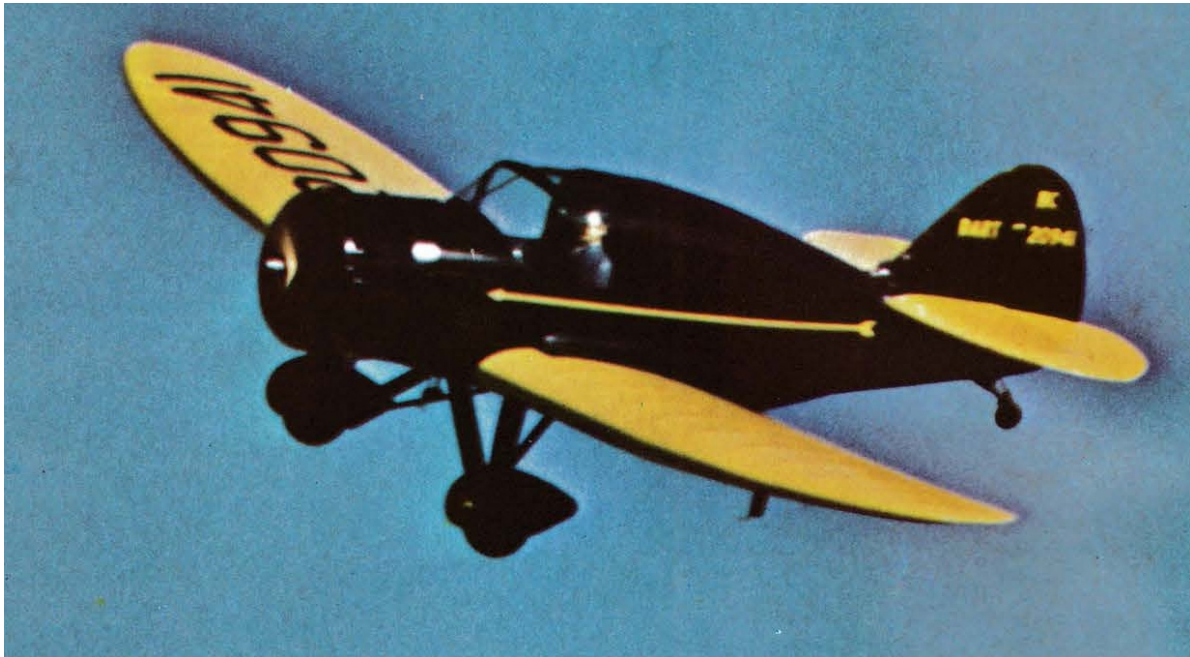


JIM MacDONALD'S



AWARD WINNING CULVER DART

This Cute Little Two-Place By Aircraft Designer Al Mooney Captured The Look Of The "Golden Age" Of Aviation

By John Eaton, Golden Era Model Service

I planned to begin this article by giving you the Random House definition of "dart": "n. 1. a small slender missile which is pointed at one end and usually feathered at the other." Well, maybe if you look real hard you can see a faint resemblance to a feather in the shape of the tail. But pointed at the other end? Not very. The only dart I ever saw with this airplane's proportions had just run into a very hard wall.

But these are just first impressions and though by modern standards the shape of the Dart is different, looking at it does not leave you with the feeling of wrongness you are left with when you look at an airplane like the Gee Bee R-5. It looks right, because it has even proportions. In Budd Davisson's view (*Air Progress*, February 1984) "cute" might be the correct description. He thought it resembled a rubber powered model. Budd's exact definition of cute in that article was "way past neat and not quite funky."

I think Budd's definition of cute is quite worth repeating and is an apt description of the airplane, but it is hard for me to see the Dart as a typical rubber airplane. Where do you put the rubber motor in a fuselage that short? A lineage is possible, though. Consider this . . .

Al Mooney and the guys are in the drafting room (*a* drafty comer of the main hangar). It's still the depression, and there's not a lot to do in new designs. The group is, well, they're bored and the immediate subject is a long, slender, low wing rubber model. It has a fairly low aspect ratio, and might resemble the Hughes racer with the speed wing. The moment of the first flight is at hand, and doubters are placing bets on how tight a spiral it will screw itself into before it crashes on the hangar floor. Mooney, even

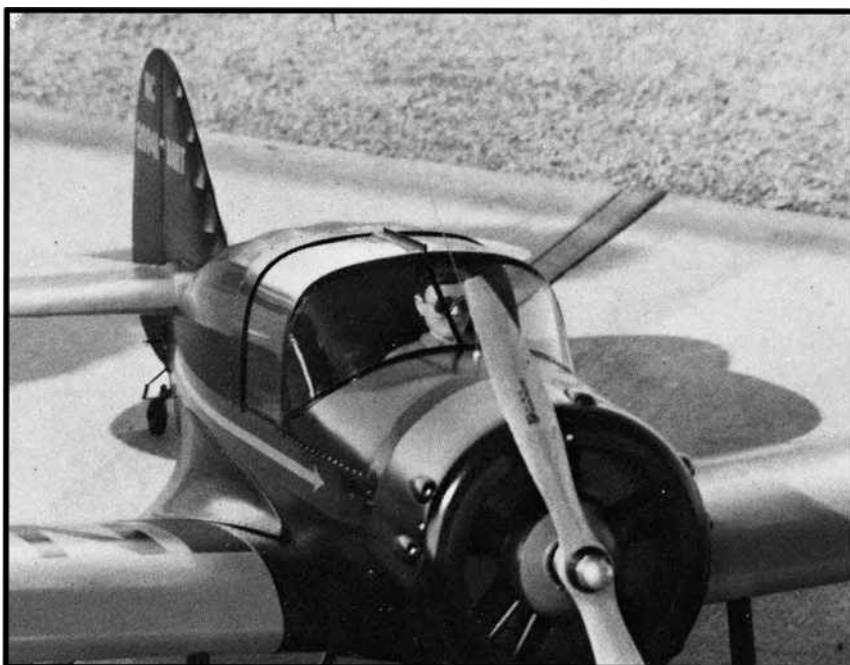
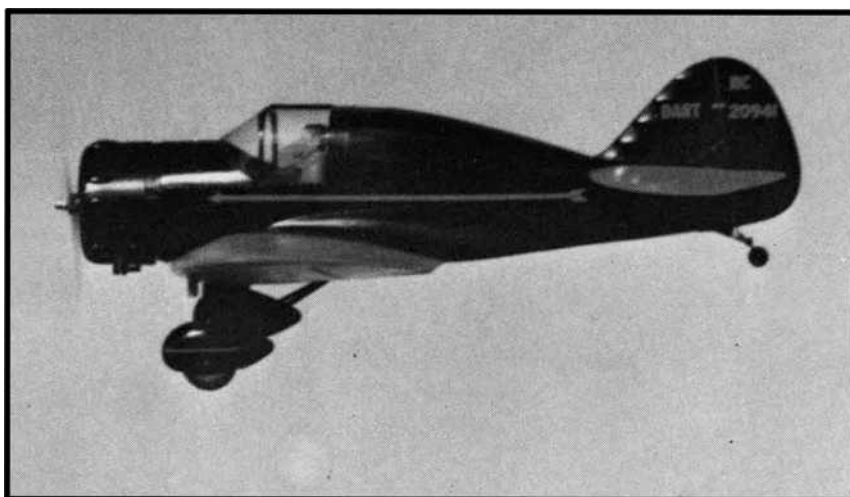
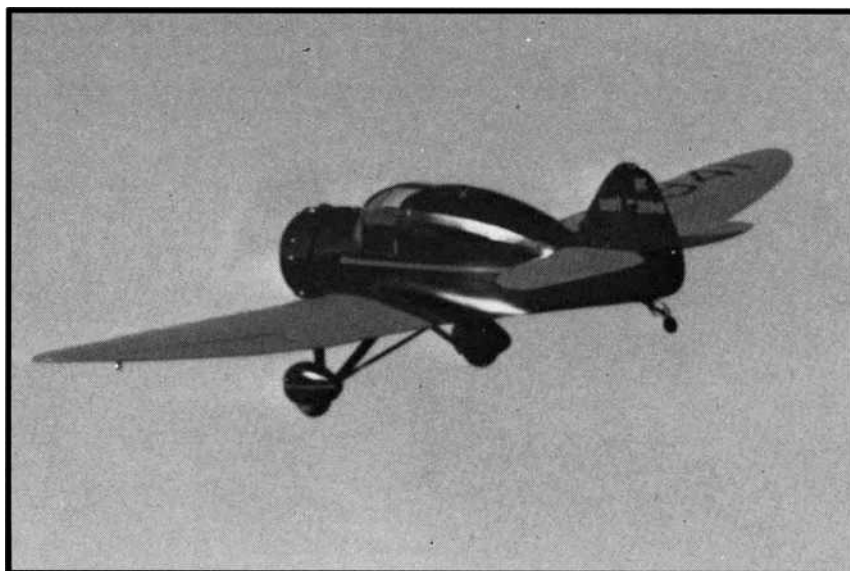
at that time concerned with getting the maximum performance out of a small powerplant, is winding the motor quite tightly.

In the next room, management and marketing are having a desperate conference, in which a conclusion is reached that the company must do something of a quantum nature to survive, like a new design of a radical nature. The meeting breaks up and goes through the door into the drafting "room." It was precisely a microsecond before that instant that Mooney overwinds the motor and "foompk" the tail of the model collapses to the nose. Even the tail post bends forward to a rakish rangle, but the staff has done an excellent job of applying the Japanese tissue and it contains all the pieces. The effect is a very short, well curved fuselage. Marketing, seeing Mooney holding the late rubber model in his hands, realizes this is the new model the company needs. For once the engineers have come up with a ship he can sell, and he didn't even have to change anything to keep them on the right track! Management also likes the new model, directs Mooney to proceed with the prototype, and heads back to the room with the heater. Mooney cannot admit he was building rubber models on company time, so he has no choice other than to do as he is told, but in a spirit of rebellion almost everything he designs for the rest of his life has a forward swept rudder hinge line.

I cannot in complete veracity say it is certain that the above is how the Dart came to be, and it's only fair to tell you the official line; that it was originally called the Mono- prep by Lambert Aircraft of St. Louis, the lessees of the drafty hangar. Lambert was a 1935 reorganization of the earlier Monocoupe Aircraft, which had failed in 1933. The Monocoupe 90A was their principal product, and Al Mooney was the chief engineer. He had previously been associated with Alexander Aircraft where he designed the well known Eaglerock biplane and the Alexander Bullet, a low wing cabin monoplane which was a contemporary of the earlier Monocoupe Company's Monocoach.

The Monoprep had an open cockpit and a thin speed ring around the engine, a 5-cylinder Lambert R-266 of 90 horsepower. This arrangement did not work out because the wide side by side cockpit disturbed the airflow over the tail, causing instability problems. A cockpit enclosure was added, the turtledeck was raised to fair with it, and a cowling was borrowed from a Monocoupe 90A and lengthened to further reduce drag from the engine installation.

The forward fuselage was widened to conform with the shape of the new cowling.



According to Lloyd Washburn of the Antique Airplane Association Dart Club, the vertical fin and rudder may also have been made a little taller at that time.

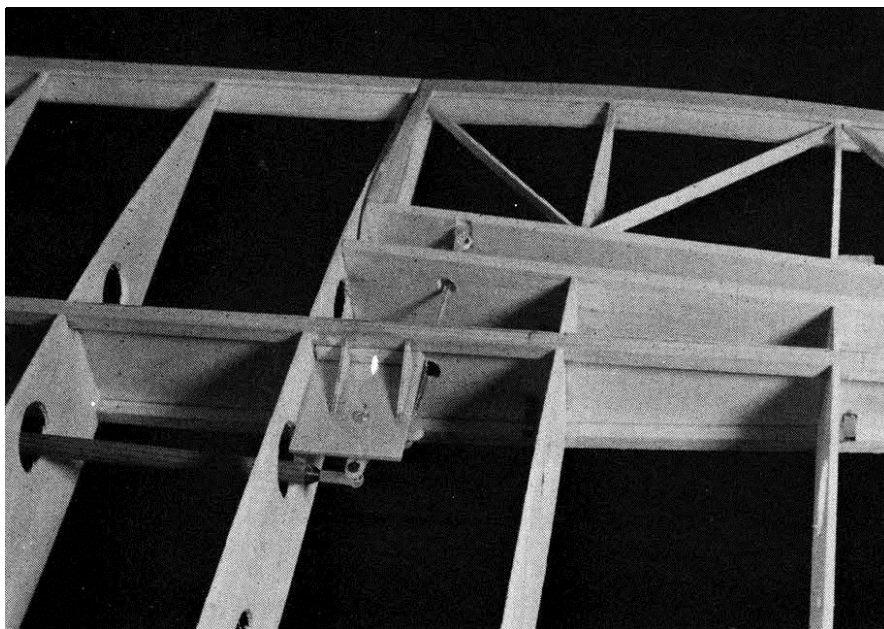
No airplanes were produced for sale by the Lambert company. Instead, Knight Culver bought the rights to the design including the prototype and four incomplete airframes which were called Monosports by Lambert because they had closed cockpits. The tooling was moved to Columbus, Ohio, in 1937 where the new Dart Corporation shared a hangar with Lane Aviation. Al Mooney came with the airplane, and of course the name of the airplane was (officially) changed to Dart. In April of 1938 ATC 674 was issued to the company, and initially covered only the Lambert R-266 powered Dart G airplanes, but additional approvals were received in 1938 and 1939 for the Dart GK with the Le Blond (also known as Ken-Royce) 90 5F and the GW which had a Warner Scarab Jr. of 90 hp.

Production got underway and Darts began to show up all over the country. It was marketed as a dependable and economical trainer that was maneuverable enough for advanced training, and the company was so proud when Parks Air College of St. Louis took delivery of five that they bought a full page ad in the September 1939 Aero Digest to announce it.

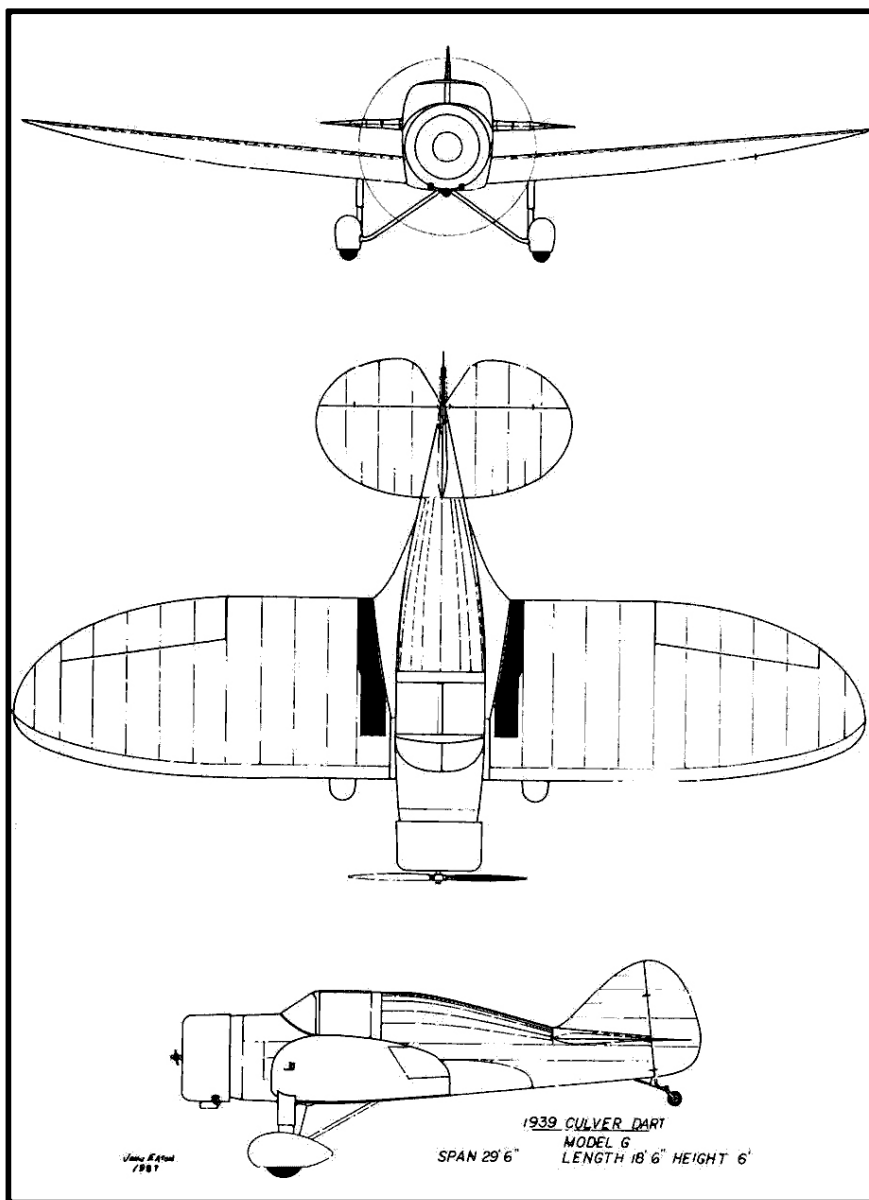
The only visible changes made during the production run at Columbus were the deletion of the side windows behind the cockpit after the fifth airplane, and in the various cowlings used. The first three Darts had the Monocoupe style cowling which sloped down in front to fair with the propeller and had bumps to allow clearance for the rocker arm housing. All other Darts had a smooth cowling which had a blunter nose radius than the Monocoupe cowl, except for the Warner powered airplanes that had the later cowling with bumps added again to clear the rocker housings.

As production of the 90 horsepower Darts continued the factory experimented with larger engines, but none were certified for production. The GK-120 had a Ken-Royce 120 horsepower engine, and Warner 125 and 145 horsepower engines were flown. The Model I was an interesting airplane optimized for aerobatics by adding a 165 Warner Super Scarab and taking away five feet of the wingspan.

This airplane also had cantilever landing gear struts. Other Darts were modified in the field, including one with clipped wings and a 220 horsepower Continental W-670 radial which must have been a Gee Bee look-alike. It was flown by Rodney Jocelyn and placed well in national aerobatic competition.



Scale Hinges on ailerons are made with Robert hinges and square brass tubing.



Air Facts was a pamphlet sized magazine edited by Leighton Collins which was popular in the days of the Dart, and Collins wrote about the Dart in the August 1, 1939 issue. The article was reprinted in the *Air Facts Reader, 1939 to 1941* (Air Facts Press 1974), a book that is required reading for anyone interested in lightplanes of the '40's. Now, Leighton was death on noise in small airplanes, and was never reticent about mentioning anything he thought might be improved. One more factor on Mr. Collin's mind as he approached the Dart was that low wing, a new thing in lightplanes of the day, and in comparing this article to others he wrote you realize he thoroughly wrung out the Dart, expanding the envelope as it is said today, looking for nasty stalls and any tendency to fall in to a spin.

The first trouble cropped up as he tried to get in the airplane, because the Pyralin windows slid up over each other but not down into the cockpit sides, and only half of the cockpit could be open at once. He says a few words about the need for more sound deadening insulation, finishing up with "that low wing doesn't keep out as much exhaust noise as you would normally expect." The next item of discussion was a roughness in the engine (it was a Dart G with a Lc Blond 90) at low idle, resulting in both the wingtips and elevator shaking "noticeably and negatively" on the ground and in the presence of a shudder in the glide "whose absence would be more satisfactory than the salesman's technically satisfactory explanation." At this point the Dart marketing manager, who furnished the subject of this diatribe free of charge including all necessary gas and oil, has developed a permanent wince. After saying that the demo flight ought to be almost an hour long and include at least four landings apparently so the prospect can become accustomed to not seeing anything out the front, Collins gets on with the flying.

The first thing he notices is that the "tricky low wing job" has good directional stability, and "rides noticeably steady in rough air." Hmm. The test continues. No rudder is needed for smooth level flight turns. He has some trouble keeping the wings level at first because he can't look to the side and put the wing on the horizon, as he is accustomed to doing with the usual highwing job.

Collins next spends an entire page trying to get the Dart to show a dark side by punishing it in all manner of power on stalls, coordinated and un-, but all he can get is a nose that falls reluctantly to the horizon or else an airplane that rolls off into a spiral to the left if he is silly about it and doesn't oppose P- factor with the rudder.

Abusing the ailerons produces no

reward, either. It simply won't spin with the power on. Finally in desperation he zooms the airplane to an impossible nose high attitude with the power at idle and boots full rudder as the airplane stands on its tail. It spins like a "top." "The stop seems sudden when the controls are centered, as you seem to hang there motionless for a second, nose down." It takes a little time to recover because the airplane has to gain some speed in the dive before the pull out to level flight. Satisfied, Collins goes on to approaches and landings, and the airplane has him eating out of its hand. On side slips: "Gather 'round you slippers, for here is the winner." Landings "are equally as exhilarating as the slip" with the noise of the wheels rolling being the first indication that the ship has landed. You realize at this point those caustic comments at the beginning were only because Leighton feared those little negatives might cause someone to quit looking too soon and not buy the darling little Dart.

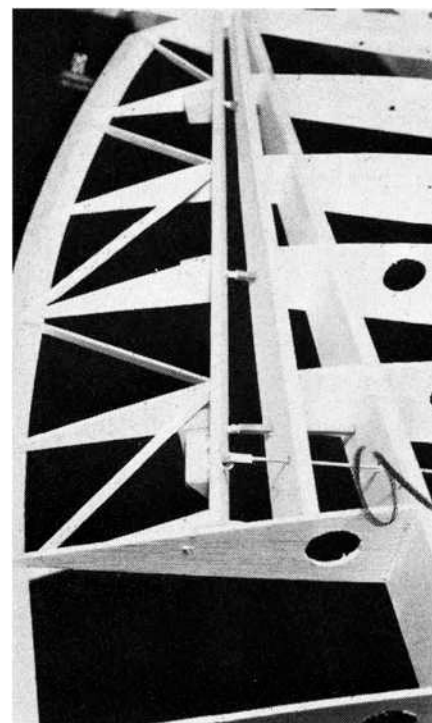
As Leighton Collins wrote those words 46 Darts had been built. A total of 50 were built by the Dart Manufacturing company, which in 1939 was renamed Culver Aircraft. Big things were about to happen for the company in the form of a new Mooney design, the Culver Cadet. Foster Lane of Lane Aviation test flew many of the Darts and also did the test flying of the Cadet prototype. In one of those comforting links through time, Foster is still active in Lane Aviation as Executive Chairman of the Board. He was a friend of Knight Culver as well and gave Jim McDonald some help with color documentation for the Dart.

The Cadet was a two place low wing retractable gear airplane that did 140 miles per hour on 75 hp and gripped the aviation public's imagination. It also pulled the plug on the Dart. Larger facilities were needed to satisfy the huge demand for the Cadet and through an arrangement with Walter Beech the Culver factory, sans Dart production line, moved to Wichita.

Production of the Dart did resume for a time after the war, when Applegate and Weyant Engineering acquired the Type Certificate and tooling. Subassembly work was done at Quincy, Michigan, and later at Elkhart, Indiana. Final assembly was done by Meyers Aircraft of Tecumseh, Michigan, who are known for their own OTW, 145, and 200. Fourteen Darts were built in 1946.

These were all GC's, powered by a six cylinder Continental A-100 flat opposed engine which finally gave the airplane a pointy front end.

I don't know, though. The airplane just doesn't have a balanced look about it with the new nose.



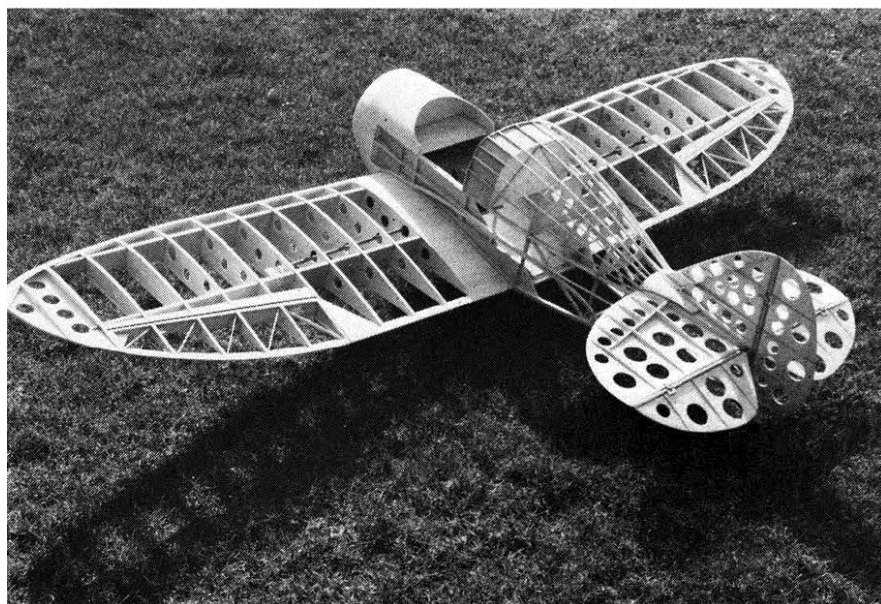
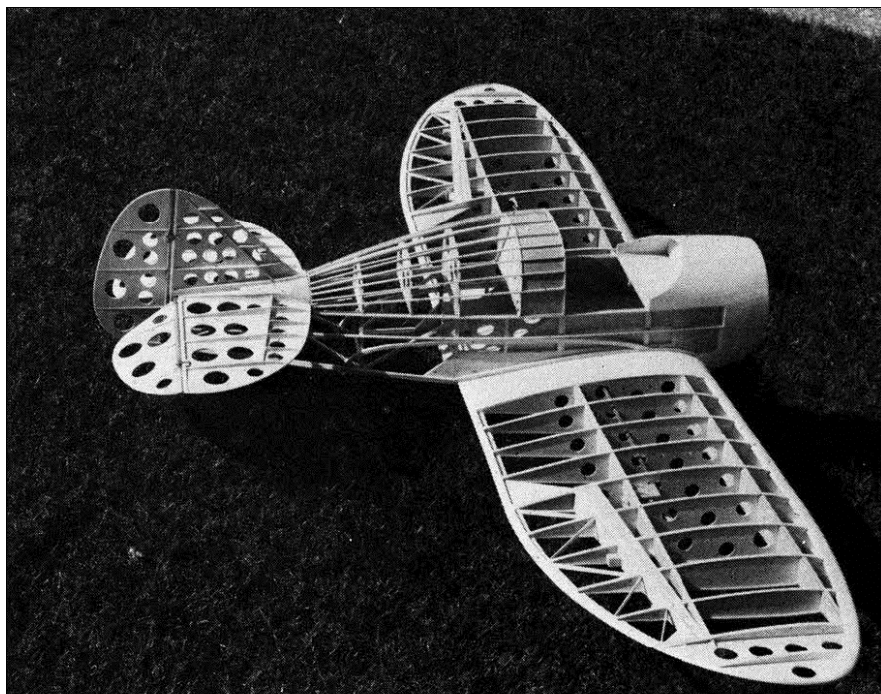
Aileron linkage is all internal. Access is through wing cover plate on bottom.

Applegate and Weyant also did some development of a retractable gear version, but none was ever built. Rumor has it that this airframe, still incomplete, was offered for sale in Trade-a-Plane not too many years ago. It seems that everyone had the dream of retractable gear in those days. I have it on excellent authority (Fred Weick) that Engineering and Research Corporations actually flew an Ercoupe with retractable gear and it showed a pretty fair turn of speed.

The Dart is a wood wing airplane with a steel tube fuselage structure. A feature of the wing was its lack of external bracing which was unusual for an open structure, fabric covered wing, and was achieved by having a double set of drag and anti-drag wires in each wing cell (the area bounded by the front and rear box-type spars and the compression struts), one set at the top of the cell and another at the bottom providing the necessary torsional rigidity. The main spar ran through the fuselage above the lower longeron halves were joined at the center of the airplane with a flange, and restrained from left/right motion by a bolt through the center of the shear webbing, where spar stresses are lowest.

As was customary for the time a gaggle of struts from the fuselage supported the landing gear outboard of the fuselage so no landing loads were carried by the spar, but Mooney was crafty and concealed the bracing inside the thick wing leading edge.

Wooden stringers are used to give the turtledeck its shape and the tail



The bones.

surfaces are welded up from steel tubing.

A number of Darts still fly today Lloyd Washburn has one which he has modified to the GK-120 version by installing the 120 horsepower Ken-Royce via the STC certification process.

Probably the most authentic restoration is owned by David Foulkes of Spring House, Pennsylvania. It has the Warner engine now which makes it a GW although Dave thinks it may have been built as a GK with the Ken-Royce and smooth cowl. This airplane is the subject of Jim's model.

Dave's airplane was originally sold in North Dakota in 1939, and then brought east in 1940 or 1941 to airports near Spring Hill, including Pitcairn Field which is now known as Willow

Grove Naval Air Station.

While it was there it was flown by Art Turner, who by an odd circumstance owns Turner Field where the Dart is now based.

Dave has been flying N20941 for a number of years now, and he and it have amassed 800 hours of flying together, which is a lot of time for a radial powered antique.

He says he rarely flies it above 1500 feet, and never when the schedule is tight. I suspect he often flies with a window up and his arm over the sill although he did not directly say so. The airplane has been very reliable, with the Warner engine having no problems save one rocker arm shaft that fell out because it had been installed improperly.

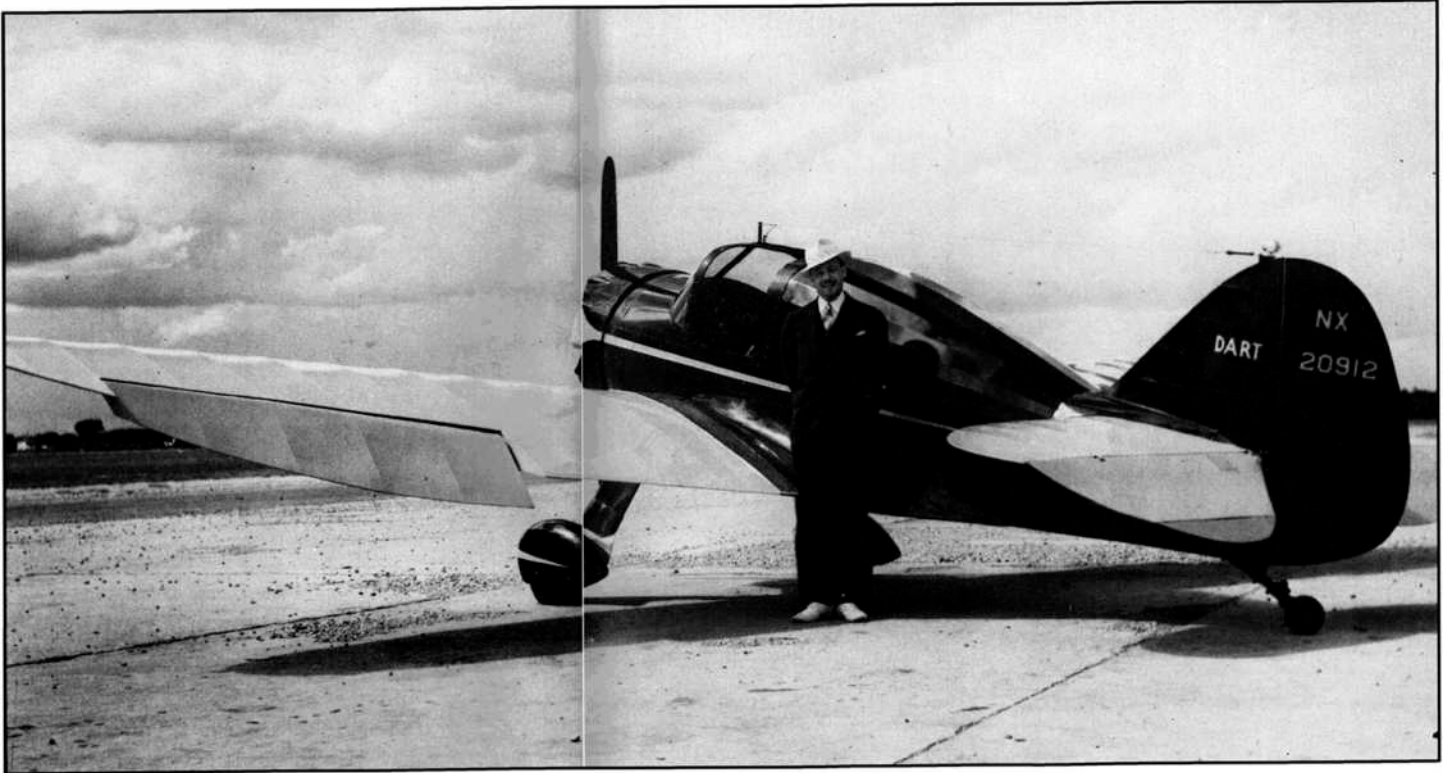
That kind of reliability is not common

among engines of that time period, when rocker arms were still greased through external fittings, but Warners always did have a good reputation. The brakes originally were a multiple disk affair with mechanical linkage and required constant adjustment, so for better reliability Dave recently changed over to Cleveland hydraulic brakes. About the only thing left that he would like to improve is the takeoff performance, which was not the airplane's strong suit when Leighton Collins flew it and has not improved with age. David went so far as to actually buy a Fairchild 24W just to get the Super Scarab for the Dart, but this didn't work out because on the way home with the Fairchild he fell in love with it and now cannot bear to steal its engine. The idea of trying an Aeromatic propeller came up as we talked, and Dave thinks he may try one of them on the 90 horsepower Warner. He just needs a little bit more for those hot humid days when the trees loom large at the end of the runway.

Jim MacDonald did a lot of research on the Dart before starting to build the quarter scale airplane. As with the Aeronca LC, he first built a smaller version from existing plans. That airplane was 1/6 scale if I remember right It's hard to tell now because only the tail remains, sticking out of a plaque over the doorway of his shop, the airplane a victim of a commercial paging system squarely on his frequency. During the research phase Lloyd Washburn was of great help in many ways but particularly as the source of the original factory drawings, many of which were for some reason already in quarter scale. These drawings were reasonably accurate, but it is obvious that the factory did not build everything according to the plans. The turtledeck bulkheads did not seem to be right, and perhaps were those of the Monoprep. Also of great help was David Foulkes, who provided many photographs of his airplane, N20941, and was also kind enough to talk to me about flying and living with his Dart, and on his dime, too.

Construction is mostly of balsa wood with built up structures. Possession of the factory drawings made it possible to follow the construction of the full size Dart fairly closely, which to my mind is the easiest way to assure an accurate model. The cowl and wheel pants are fiberglass and are available from Golden Era Model Service. The cowl is the smooth type as it comes from the mold, and the bumps are added by gluing on heat formed plastic teardrops.

There is a lot of taper to the fuselage and the sideframes must be framed up on a drawing that is separate from the main sideview so everything will be in the right place during final assembly of the fuselage.

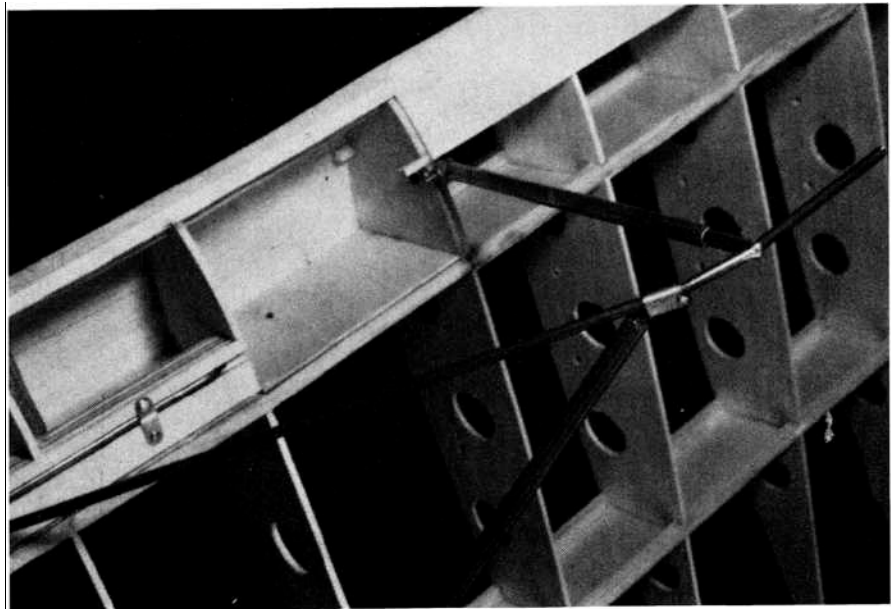


Model I Dart. Identity of dapper gentleman unknown. From the John Underwood Collection.

The airfoil used on the model is exactly that of the full size ship, and is a 15 percent section at the root getting thinner at the tip Mooney used a NACA 3414 airfoil tapered to a 3408 on the Cadet and he may have previously used the same airfoil sections on the Dart. The wing spars are the jig wing assembly. The wing is a one piece assembly because we felt the added weight and complexity of a two part wing was not warranted by the slightly more than seven-foot span.

Takeoffs are not a problem with the 1/4 scale Dart The OS FS120 allows takeoffs at little more than half throttle and fits entirely inside the cowling. As is characteristic of most 1/4 scale airplanes, the Dart flies pretty much like the full size airplane Because of the wing's low aspect ratio the chord length over 80 percent of the span is a relatively long 18-1/2 inches. The wingspan is 88 inches and the wing area is 1476 square inches The prototype weighs 13.5 pounds with detailing and finishing suitable for the Scale Masters level of competition, which results in a 21 ounce per square foot wing loading At a landing speed of 15 miles per hour, quite low but safe for the airplane, the wing is still flying at a Reynolds number of 200,000, well above the troublesome range and there is no tendency to tip stall at flying speeds As is the case with the full size Dart the model will fly at a very high angle of attack which is due to the low aspect ratio planform.

The most extreme example of the



The Dart has plenty of landing gear struts. Large tires provide all of the shock absorbing on the model.

effect aspect ratio has on angle of attack is the delta wing, which can have an aspect ratio of less than one (.5 with a 60 degree leading edge sweepback).

A delta wing never really stalls in the classic sense, it just builds up so much drag it can't be made to fly anymore. (No, I don't care about the case of the airplane that has more thrust than weight. That's not flying, it's ballistics!)

A nice side effect from the standpoint of

flying the model is that since there is such a wide range of angle of attack to operate in you can gauge your performance reserve by how high the nose is riding. Don't try that with a skinnywinger!

Dart landings can be made by rolling the tailwheel on first, always the best way to land a conventional gear airplane if you don't like to bounce, but this isn't a comfortable maneuver if you are worried about tip stalls.



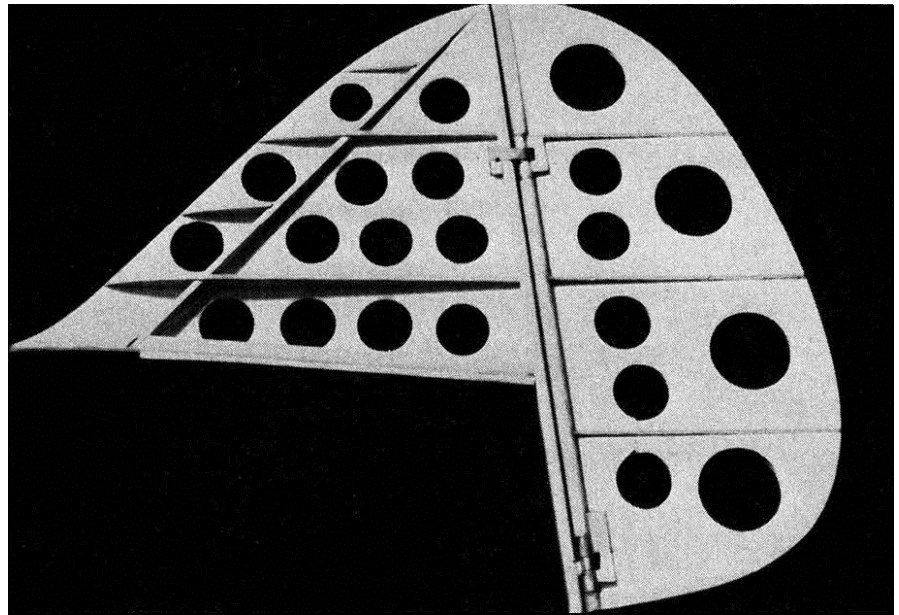
Debbie Reifer shows the sire of the Dart.
Photo by Dave Reifer.

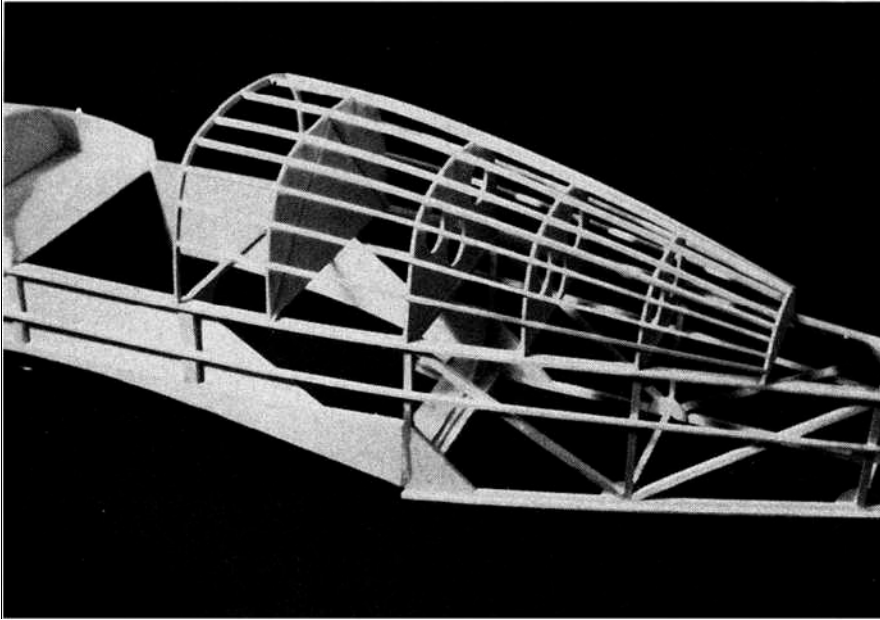
Rudder and elevator hinges are of sheet brass and tubing, and are the same design used on full-size Dart. Very little hinge gap results.

Somewhat surprising to me is the close similarity between the model's spin and Collin's description of the spin. With power on it will not spin, because it rolls off into a spiral first. The power off spin must be entered by coasting upward in a very nose high attitude, with full elevator and rudder just before the airplane comes to a stop. The rotation is very rapid, but when the sticks are centered the airplane stops the spin right away, pointed straight down and not going anywhere.

Other maneuvers the airplane does well are inverted flight and anything involving rolls. There is little trim change between upright and inverted flight, and the ailerons are smooth and precise with little adverse yaw. Stall turns are pretty good too. Loops are nice and true as long as you have the rudder trim set correctly and you remember a touch of right rudder during the pull up.

There are really only two problems with the Dart. One is that the wing, when removed from the airplane, looks so much like a surfboard that you dare not leave it unattended near the beach. The other is that it's so darn cute that it might not be macho enough to win at the Masters, but those of us who fly airplanes for the fun of it won't be bothered by that.#





Fuselage is light considering its large cross section. Longeron/vertical intersections are gusseted for strength.

