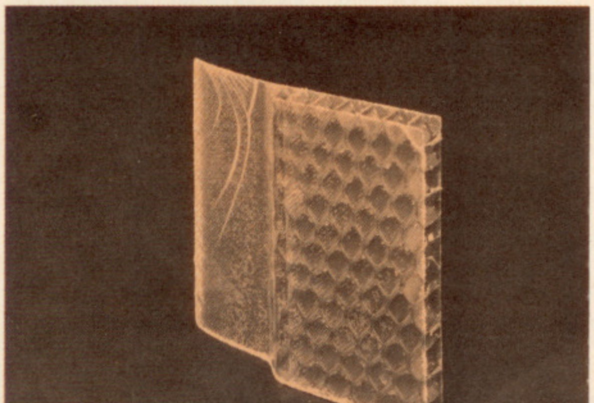
Robert Drake, manager of Piper's plastics division at Vero Beach *Photo by Bob Palmer*

Piper Builds A Plastic Plane

'Papoose' prototype nears completion at Florida plant. Search for low-cost, general aviation aircraft leads manufacturer to Fiberglas and resin. Tests prove structural strength of new material

by MAX KARANT • AOPA 18
Photos by the author



Fiberglas bonded to a honeycomb of kraft paper provides the strong top and bottom of the "Papoose's" wing skin. Photograph shows the kraft paper honeycomb used in the 9/16-inch skin and a segment of the laminated covering. Measuring scale on the AOPA Air Aid gives you an idea of the size of the honeycomb's pores

Smooth contours of the plastic Piper "Papoose" stand out in this photograph taken at Vero Beach, Fla. Cockpit is covered with bubble-type canopy, which eliminates the need for a door

Is there a plastic airplane in your future?

The chances are excellent that there is, if one is to base his judgment on the knowledge and 24 years of experience of Robert Drake (AOPA 90220), manager of the plastics division of Piper's Vero Beach plant, as revealed in an interview with him.

One of the country's top experts on Fiberglas and plastic structures, Drake produced the first plastic boat about 15 years ago for the U. S. Navy. It was 28 feet long and, at the time, the largest such piece of plastic in the world. At that time Navy officials asked Drake the same question AOPA asked him recently: Practically speaking, how big can you make such a boat? Drake told them then that he could see no limit to the size of such boats, and today all small boats produced for the Navy are Fiberglas-plastic. Ironically, the only wood or metal small boats now being produced for the Navy are on a purely experimental basis.

Drake answered this same question about airplanes by saying that he has a much stronger feeling about the favorable aspects of the plastic airplane's future than he did about the small boats. And he says he could build an all-plastic DC-3 right now.

Under the engineering direction of Fred Weick (AOPA 9893), head of Piper's Vero Beach Development Center, Drake and his team are nearing completion of the first all-plastic Piper airplane. It's the experimental *Papoose* PA-29, shown in the accompanying photographs. A two-place, side-by-side low-winged monoplane, the *Papoose* has fixed landing gear and a 108 h.p. Lycoming O-235-C1B engine, the same engine as is presently in the *Colt* and saw such wide service in the Piper *Super Cruiser*.

Wing span is 25 feet, length 20 feet, 8 inches, and height 7 feet. Because the *Papoose* is nothing but an experimental prototype, they're not even guessing (for publication, at least) at the performance. One reason is that actual flight performance is a secondary consideration; their main interest in the *Papoose* is structural and economical. The present structure has been made substantially overweight so that Drake's division and the test pilots can give the airplane a thorough working-over. Gradually, they'll start reducing the weight of various components as they work toward the kind of structure to be used on future Piper models. The present experimental structure on the first *Papoose* is so strong that the engineers tested it to 210% of maximum design load (the FAA requires it to withstand 165%), held it there for about 15 minutes—and then the testing machine, not the structure, failed. A comparable metal structure would have to be considerably heavier. At the moment, Piper doesn't know how high this plastic structure will go before it fails, although tests to destruction are scheduled.

EDITOR'S NOTE: In 1958, Piper Aircraft Corporation, Lock Haven, Pa., announced that it was surveying the market to determine whether there was a demand for a low-cost, two-place airplane without frills and which could be produced in a "production system that permits little or no variation from standard." A tabulation of 1,009 of the replies received to a questionnaire, sent out in connection with the survey, indicated that there was such a demand ("yes," 938; "no," 69). Piper researchers and designers were put to work on the project and the "Papoose" prototype resulted.

The structure itself is an exclusive development by Drake and his staff, and has made a hitherto complex and costly process, involving several steps, into a one-step process that bids fair to lower the cost of building an airplane by a substantial margin. So far as Drake is concerned, the Piper process is ready for actual aircraft production.

The ingredients that go into the wing are Fiberglas, the appropriate bonding resins, and honeycomb made of kraft paper. Two thin layers of Fiberglas comprise the top and bot-

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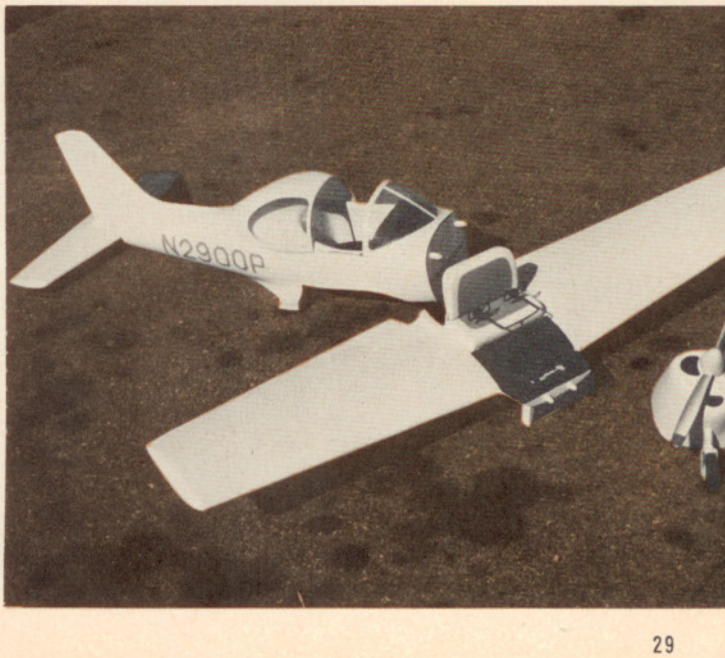
Fixed tricycle gear of plastic plane was designed with wide main tread in order to give extra landing and takeoff stability. Two-place "Papoose" has side-by-side seating and is powered by 108 h.p. Lycoming engine

"Papoose" might be called a "three-part" airplane, as photograph shows. Everything is attached to the wing in final assembly, in much the same way a plastic model plane is put together. This assembly simplicity is expected to cut down costs



Plastic Plane

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tom of the wing skin which, at the moment, is $^{3}/_{16}$ of an inch thick. These layers cover the top and bottom of ½-inch thick paper honeycomb which is itself impregnated with plastic by Douglas Aircraft, the company presently producing the honeycomb for Piper.

The one-shot process developed by Drake and his staff consists of placing the bottom Fiberglas sheet in a specially developed mold, the paper honeycomb on top of that, then the top layer of Fiberglas on the honeycomb. Then, in the new Piper process (some parts of which Drake believes will be patentable) all three are molded together into a precision, permanent unit in the single operation. Previously, the same general results could be achieved, but by separately molding each part of the structure to the other, a tedious, more difficult, and considerably more costly operation. The Piper process already has attracted considerable attention at Douglas and Boeing.

The entire *Papoose* wing and fuselage are made of this material, in single integral pieces. A cross-section of the wing is just a hollow shell in the form of the airfoil, with a single vertical "separator" (made of the same material) molded in place inside, along the length of the wing's centerline. Except for this separator, there are no spars, ribs or stringers. With a little additional sealing, the entire wing could be filled with fuel.

"What's wrong with plastic structures?" AOPA asked Drake. "What underlies some of the troubles with plastic boats AOPA has heard about?"

Drake was quite candid.

"I spent many years in the plastic boat business. I was responsible for the development of the first such boat for the Navy. But in my opinion, many of the boat companies that have run into trouble have done so for reasons other than the basic materials themselves.

"The key to the success of such plastic structures is the choice of the proper Fiberglas-resin compounds," Drake added, "and many boat companies have failed because they simply lacked the technical knowledge of their subject. Other companies failed because they started out with proper technical people whom they discharged after the design was finished and tested. Then they would hire 'backyard mechanics' to handle the actual production, and the whole program would deteriorate."

Basic reasons for failure of the actual product, Drake said, was due to "watering-down" of the basic Fiberglas-resin compounds in an effort to cut costs. "The common failing," Drake explained, "was the diluting of the resin with cheap styrene. And when they exceeded a certain percentage the boat would simply fall apart.

"It's just like a similar result with concrete," Drake said in seeking an analogy. "If you increase the amount of sand in a given batch of concrete, say 10 to 20 times, the result would be disastrous. Yet you wouldn't condemn concrete as a structural material because of some such mishandling, would you?"

Any reputable aircraft manufacturer today should be in a lot better position to go into plastics than is the average boat manufacturer, Drake feels. "Take a company like Piper. It's just fundamental to our very existence that we have ample technical knowledge of our subject. We are quite accustomed to living with constant quality control, constant production surveillance. And it's quite the natural thing for us to produce our products with the constant knowledge that we must meet minimum standards set by the FAA — something else the boat manufacturers don't have. Obviously, we are well acquainted with FAA requirements, and we work accordingly."

Does the plastic airplane now foreseen retain the basic attributes of the metal plane? Yes, and more, Drake says. "We are already at the point where we believe we can build a complete plastic airplane that will meet all of the requirements now met by metal aircraft. Our tests will indicate to what extent this is true. In addition, there are other fairly obvious advantages. The plastic airplane will be corrosion proof, impervious to salt water, can have its colorings impregnated permanently in the plastic as well as painted on the surface, and—unlike metal—have an almost infinite life. Metals all are crystalline in their structure. If you bend them enough times the crystals separate; that's called fatigue. Fiberglas filaments never fatigue. The only way you can make these filaments fail is to bend them beyond their actual yield point. But unless you do that, the structure will last indefinitely."

Aren't such plastics inclined to be stiff and brittle? we then asked. "It's possible to make a Fiberglas structure as soft and pliant as rubber," Drake replied, "and it's also possible to make a similar structure so rigid that it would crack if you shake it. The key is the compound that you select in between these extremes. We have selected the compound for what we believe to be the best plane structure. We will use that compound to make this airplane, simply by maintaining rigid control over the compound itself and all stages of its use."

Piper is no novice in the field of plastics. The company has manufactured Plexiglas canopies for Grumman fighters, in addition to its Plexiglas work on production Piper models. Many current production parts are formed of Royalite, a thermoplastic material used for instrument face plates, wing tips, etc. More recently, they've become quite proficient in the field with the manufacture of Fiberglas plastic tanks for the *Pawnee* agricultural plane, and nose cowls and wing tips for several models, including the *Cherokee*.

We then asked Drake the point-blank question: Do you think Piper could produce the *Cherokee*, *Comanche*, *Apache* and *Aztec* entirely in plastic, retaining the same empty weight and structural strength they now have in metal? Drake's answer was also to the point, "Yes, I'd say we're close to being ready to go to any size airplane Piper wants."

The wing of the *Papoose* will be virtually glass-smooth. No rivets, screws or overlapping panels. What aerodynamic advantage will this give? "Not much on the *Papoose*," Drake replied, "primarily because it's a pretty slow airplane to benefit from such fine points. But in our faster models, that's something else again. I would guess that up in the *Aztec* class, that structure would increase its speed as much as five or 10 m.p.h. To cite the other extreme, in our very high-speed jets their wings are not only glass-smooth, but even an overnight layer of dust makes a difference."

Aside from the plastic composition itself, what other factors will bring about savings in producing such airplanes? "To start with, the entire *Papoose* wing will contain only 35 parts," Drake said. "And it is all put together in one piece—seats, landing gear, engine mount attachments, everything to be found attached to the wing in the finished airplane. The fuselage is molded in two shells, as is the tail. As a matter of fact, the best way to describe the actual assembly of the *Papoose* is to liken it to one of those plastic model-airplane kits."

What about repairs? "Here is where the plastic airplane should really shine," Drake replied. "When we first started using Fiberglas components on our present models, we felt it would be wise to have a standard Piper repair kit. We have them, all right, but very few have been sold. Owners have apparently found they can easily fix these parts with a Sears repair kit, or they call out a local boat repair man if it's a more complicated problem. Also the parts do not require much repairing, evidently.

"We've deliberately smashed and cut our *Papoose* wing, just to see how hard it is to fix. All that's necessary, we found, is to saw out the damaged part—paper honeycomb, Fiberglas and all—put in a new plug of honeycomb and Fiberglas patches top and bottom, then sand them down. Anyone can do it, and the patch is as strong if not stronger than the original structure."

How is the FAA reacting to all this? "Well, they've been very interested and cooperative throughout the development of the *Papoose*," Drake said. "They have no requirements which state what type of material or construction must be used, so that plastic construction is not objectionable. The FAA is very much interested in promoting activity in our field, and if we can bring about a real advantage to the user and to the industry through the use of plastics, we're sure that they will do anything they can to help with the development."

What is the present timetable for the *Papoose?* "Flight test is just a few months off," Drake told AOPA. "After that, it's up to the test pilots and the engineers. Then, of course, the company management will ultimately decide how—and if—Piper will proceed with plastic aircraft."

If the *Papoose* proves to be as good an airplane as it now looks, it—or a development from it—probably will be the ultimate replacement for the *Colt*. For the moment, however, the *Papoose* is "neither a 1962 nor 1963 model." It has been modified a number of times in the three years Drake has been working with it, and many more changes will undoubtedly be needed before this basic design can be released for production and sale. END