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DEVELOPMENT OF THE PA-15
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It is my feeling that if the aviation public were able to have a better understanding of what goes on inside the personal plane business, the relationship between the public and the industry would be appreciably improved. The people would know, more or less, what to expect of the aircraft producers, and why their products turned out as they did. They would not be so disappointed when artists' conceptions failed to become live aircraft, but would learn to expect continual improvement in models, and moderately paced evolution towards personal planes that someday will make current models look and fly like early attempts of the Wright brothers.

The development of new models is a phase of the industry that is probably least familiar to the public. Development is naturally kept as secret as possible, as in the case of the automobile business, not only from the public but from competitors and other professionals within the industry,—that is, at least until the new model is presented. Actually, there isn't a great deal to hide, and new airplanes are extremely difficult to keep secret in any case; you have to test them out where every passerby can have a look if he wishes.

It is easy for a designer to point out, in verbal discussions of a new aircraft model, just exactly why every feature of the airplane is as it is. For someone not familiar with the reasoning behind the development of the model, it may be hard to understand why the plane has certain characteristics and details, and what prompted the designer to turn out a product with its particular specifications.

In the case of the PA-15 (Vagabond), the general specifications were laid down about September 12, 1947. They were clear and concise: it was to be (a) Low cost, under $2000 if possible (b) As safe as a J-3 (c) Side by side, of tubing and fabric construction (d) Comfortable, roomy, easy to enter and leave, and (e) Available for production in the minimum time— less than six months if possible.

The rest of the specifications were left to the designers, except that the model was to be built around the Lycoming 65, for reason of low cost, light weight, and economical operation. The most difficult requirement was the time schedule. Ordinarily a new model development would take at least a year, and even a minor modification such as from the J-3 to the PA-11 required six or eight months. During this project, moreover, the personnel available for engineering work were at a low minimum, the number having reduced from about 130 to roughly one fifth of that figure, and many of those left were busy on other projects.

The PA-15 was started on September 15, or actually was conceived mentally about on that date, and drawings and mechanical work started shortly thereafter. Three men were put on the job, all that could be spared at that time, and they were helped frequently by one additional designer. In the first week, the design conception was more or less frozen, and the wings were built up.

At the end of the third week, the fuselage frame was complete, the wings and struts installed, the landing gear complete and mounted, and the motor mount finished and bolted on. During the fourth week the more time consuming detail work was begun: the seat, fuselage cowl, windshield, and part of the control system were made up. By the middle of the sixth week, the control system, fuel systems, baggage compartment, wing fairings, cockpit door, floor boards, instrument panel, and all other components were finished, and the aircraft was ready for covering and assembly.

On Wednesday of the seventh week, forty-five days after the conception of the model, the PA-15 made its first flights. Considering that the development had been done by an average of about four men, averaging forty-five or fifty hours per week, this should prove to be some kind of a record. Other records must have been broken in the weeks that followed, as pressure was maintained on the project and the necessary steps before production could begin were accomplished at a rate that surprised practically everyone.

During the week following the first PA-15 test flights, it was determined that the aircraft met all of the original specifications, and that it would pass all CAA flight requirements. The one respect in which it failed was in meeting the nose up trim requirement as established in the latest CAA regulations. This provides that the airplane must trim, with free controls and the most nose-heavy flight condition that is to be substantiated, to a power-off gliding speed not to exceed 140 percent of the stalling speed. In the PA-15, to get approval of a forward center of gravity position that would permit future installation of heavier propellers, and other equipment ahead of the plane's center of gravity, it was necessary to meet the trim requirements with about 75 pounds of ballast just behind the firewall. To do this, the fixed stabilizer was set at an angle of 4 degrees negative in relation to the chord line of the wing, a larger tab was installed, and a bungee spring which applied an upload on the elevator at all times was added. The bungee, which is also incorporated in the PA-11, PA-12, and PA-14, accounts for the elevator remaining in the full up position and the stick being full back when the plane is not in flight.

On November 5, one week after the first flights, the 15 was torn down and brought into the experimental department for static tests. Between this date and February 4, all static test work and stress analysis was accomplished, the model was completely drawn up
(approximately 525 drawings) a second plane was built, and company and CAA flight tests were satisfactorily completed. Tooling up for shop production was carried on

simultaneously. On February 4 the CAA issued a Temporary Certificate for this model, and on February 20, the first production model rolled off the line. This was about five months and one week after the project began.
The principal objective in the development of the PA-15 was to reduce the list price of the aircraft and still provide the necessary elements for safe, comfortable flight. Low cost was emphasized above all else.

The cost factors in conventional method production are more or less fixed for aircraft of a given weight and type of construction. Material accounts for fifty percent of the manufacturing cost, figuring very generally, with the engine usually half of the total material bill. Labor, overhead, and profit make up the other half of the costs, profit normally squeezing in weakly at the bottom of the list.

The most logical means of reducing the cost of this new model was to tackle the biggest factor, the bill of materials. Most of the items on this list were fixed in price—engine, wheels and brakes, instruments, propellers, fabric and dope, steel tubing, etc. The only way to reduce their cost was to decrease the quantity of raw material used, or in other words, to reduce the size, and, more important, the weight of the plane.

The problem then was to develop a model smaller and lighter than any previous models of recent years, with more room, better performance, and equal or better flight characteristics—a package with smaller exterior dimensions, a larger interior, and at least equal qualities.

The 15 was made 18 feet 8 inches long, almost 4 feet shorter than earlier products. The wing span was set at 29 feet rather than the 35 feet of production planes, decreasing the wing area from 178.5 to 147 square feet. The wings used were PA-11 panels with 40 inches, or one drag bay, cut off the inboard ends. Identical panels, incidentally, had been experimented with before the war on "clip-wing" trainers, and Beverly Howard's famous acrobatic Cub has wings of the same size.

The reduction in weight of the PA-15, which was accomplished mainly by decreasing the fuselage and wing size, amounted to a little over 100 pounds, so that it weighed about 625 empty compared to 735 pounds for a PA-11.

A considerable saving in cost and weight was accomplished by simplification of structure and mechanical detail. The labor hours per plane were reduced by about twenty percent, and this saving reflected directly in overhead chargeable to each hour of direct labor, reducing manufacturing overhead by a similar one-fifth.

The PA-15 was equipped with only a single set of controls primarily as a cost and weight saving move. An accumulation of pounds, or ounces, saved here and there on the model results in an empty weight low enough to establish a reduced maximum loaded weight.

As the gross weight is decreased, the structure can be lightened, and the whole project is benefited. The farther the empty weight is retarded, the less the customer pays for the product. This is a cycle that usually works in the opposite direction—equipment is added, the empty weight goes up, the gross weight has to be raised, structural weight and power plant weight increases to take care of the added gross, the price goes up, and so on.
The single controls were also specified as a sort of experiment to see how the public would react.

It was felt that the plane was easy enough to fly so that anyone who had checked out in a tandem trainer or any side-by-side plane could jump in and fly it with no more than a little oral help. The controls were made similar to trainer controls (stick in the right hand, throttle and trim on the left) for that reason and for reasons of economy. The stick is a requisite in a truly minimum design because a wheel control is inescapably heavier, and more complicated and costly.
The PA-15 was intended to be principally a low cost, private-owner, flying club, or rental airplane, and as such should not require duals. Someday, it was reasoned, personal planes may not require dual controls any more than automobiles do. Possibly this would be a step in that direction. These reasons, and the fact that the single control resulted in an unobstructed space on the right hand side in which even a seven (?) footer could relax, decided the single control issue.

The Thorpe Skyscooter, a highly successful light weight personal plane built on principles similar to those of the 15, also was designed with but one set of controls. The idea has very distinct merits— and demerits, as everyone realizes.
Like other features of the 15, the single controls were not incorporated without considerable analysis and debate.

The elimination of the shock absorption units on the 15 was a matter similar to that of the controls. Actually the 800x4 tires, a size from which we hesitate to deviate because of superior shock absorption and floatation qualities, will absorb more shock than most of the landing gear shock units on our aircraft. The low pressure tires deflect, in drop tests, more than half of the total deflection of the tire and landing gear. The load factor developed in the PA-15 during the extensive drop tests inflicted on this gear, was surprisingly moderate, amounting to about 5 g's. The gear was pounded unmercifully without incident. With a normal gross weight of 1100 pounds, the 15 has been flown at 1500 pounds, and the same gear has been subjected to numerous flights on a test model at weights up to 1700 pounds.

The smaller wings of the PA-15 appeared desirable for many reasons other than those of economy and weight saving. With standard PA-11 ailerons, the rate of roll of this model was increased to a marked degree because the dampening effect of the larger panels was reduced. The ailerons tended to remain effective through a normal stall more so

than on full span wings, and aileron yaw was diminished by virtue of the shorter arm at which the yawing force is applied.

The shorter span does not detract from the lateral stability of the 15 in flight, but appreciably adds to its stability on the ground in high winds. The wing loading is still only 7.5 pounds per square foot, or half a pound more than that of a PA-11.

The longitudinal stability and spinning characteristics of the PA-15 were a pleasant surprise. In earlier short-coupled models, some difficulty had been experienced with these characteristics, but in this plane longitudinal stability was quite positive, and spins were very hard to hold over about ll/2 turns unless power and crossed controls were used.

All in all, the reduced exterior dimensions of this model appeared to improve its flight characteristics, and it is obvious that this angle of reducing weight and cost by cutting the overall size while maintaining desirable flight qualities should be the subject of continued investigation.

Since light planes were first contrived some fifteen years ago, they have all been going through the accepted cycles of modification and growth—the same cycle mentioned earlier, and the same one that automobiles are following. They appear to be improving themselves out of the volume market.

Light planes have become more complex, heavier, more powerful, more expensive to purchase and to operate. They have greatly increased their utility, it is true, but the dominant factor in smaller planes, that of low initial cost, has been largely neglected.

Our earliest models weighed about 500 pounds and cost $1200, back in the middle 1930's. Prewar trainers weighed approximately 630 pounds and sold for $1600 to $1800. Present day trainers are up to 735 pounds and $2500. Actually this price is not out of proportion considering the thirty or forty percent decrease in the value of the dollar, and the improvement in the aircraft.

The PA-15 is an attempt to start out fresh once again, to get back to a minimum plane without sacrificing any of the improvements developed in recent models. If it turns back the tide of increasing initial and operating costs even to a limited degree, it should be a successful contribution to the personal plane field.

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