

INTRODUCTION

THE AIRPLANE

FLY BABY is a structurally simple and easy-to-fly airplane designed to the requirements of the Experimental Aircraft Association for home construction and storage in a space 7' x 8' x 20', which is equivalent to the standard home garage.

Great emphasis has been placed upon safe flight characteristics and good low speed performance for takeoff and landing at some sacrifice of high speed. The structure has been designed for standard airplane engines from 65 to 85 horsepower and the aerodynamic features are of sizes and proportions suited to obtaining the best all-around performance in this power range. Because of this, there is not enough advantage to be gained from using engines of significant higher power to offset the cost and weight penalties. Increasing the power to increase the aerobatic capability is not recommended. FLY BABY will do simple recreational aerobatics very well but is not intended for rough air show or competition maneuvers.

Because of the increasing difficulty of obtaining the 65 to 85 hp engines that are no longer manufactured, many would be builders have written in to ask if the 100 h.p. Continental O-200 engine can be used safely. The answer is yes; the O-200 can be used without any reinforcement of the structure. In fact, engines up to the 108 h.p. Lycoming O-235 can be used safely without compromising the structure or imposing a weight penalty. Engines heavier than the O-235 are not recommended.

Questions have been asked, too, about the suitability of the Volkswagen engine as a substitute powerplant for FLY BABY. While no one has tried one yet, the designer does not feel that this engine has the necessary displacement to make a good-flying airplane of FLY BABY and does not recommend it.

Allowance has been made for the fact that many builders will want to make minor departures from the basic design, and some acceptable variations are shown in the photo page. However, no changes should be made in really basic structure or in the size, setting, or location of the flight surfaces.

Low wing monoplane configuration was chosen for the basic Fly BABY design for several reasons - structural simplicity, suitability for low-cost easy-to-rig wire bracing to fuselage and landing gear, maximum visibility for the pilot, and ease of pilot entry to the cockpit.

For those desiring to convert the basic low wing FLY BABY to an entirely different machine, supplementary drawings are available for biplane wings which can be fitted to the same fuselage, tail, and landing gear as FLY BABY 1B. The basic monoplane is FLY BABY 1A. The biplane wings are not designed to fold.

As a biplane, FLY BABY is comparable to most other home-built biplanes with the exception that it is slightly larger than average, as is the monoplane, resulting in lighter wing loading and improved takeoff and landing characteristics. The use of sweepback on both wings is to permit interchangeability of wings between biplane and monoplane arrangements without changing the pilot's seat, which was originally determined by the wing location and balance requirements of the low wing monoplane with straight wings. To keep the pilot behind the upper wing center section

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instead of under it, the upper wing had to be located considerably forward of the lower, with sweepback used to bring the center of pressure aft to the proper location.

Because of the significant differences in wing bracing, the biplane FLY BABY can use a shock-absorbing landing gear, even a single-strut type if the builder cares to work out the structural modifications. The rigid landing gear, however, has proved quite satisfactory for over 1300 hours of flying on the prototype FLY BABY and some 136 examples built from the plans. Both versions can be fitted with Edo D-1070 pontoons or equivalent home-built versions.

AEROBATICS

This is a subject of great concern among amateur airplane builders and pilots. For an in-depth discussion of the problem, plus others involving the structural integrity of homebuilts, see the article on pages 8-29 through 8-31 that has been reprinted from the Experimental Aircraft Association's magazine SPORT AVIATION.

THE MATERIALS

The structure of the standard FIX BABY is all wood which was chosen in consideration of relatively low cost, general availability, and the shop facilities, tooling, and skills possessed by the person undertaking the construction of a full-scale airplane for the first time. Anyone who can get a passing grade in a high school woodshop course should be able to successfully build a FLY BABY.

Metal work, and especially welding, has been kept to an absolute minimum. There is so little of the latter that the builder can cut his material to size and then take it to a professional shop to have the work done quickly without compromising the "do-it-yourself" requirements of airplanes to be licensed in the amateur-built category. It was intended to develop an alternate steel tube fuselage for FLY BABY, but so little interest has been shown that the designer cannot justify the time and cost of building a test specimen and making drawings.

At the time FLY BABY was built in 1960, the use of some components from production commercial aircraft was permitted and still is. One FLY BABY now uses shortened wings from a Luscombe SA. The most commonly used items are engine mounts, fuel tanks, and cowlings. However, for certification as amateur-built, the airplane must be 51% built by the builder.

Because the wings are wire-braced to the axles, landing gears from production airplanes should not be adapted to FLY BABY unless they are made rigid in the process. This applies to the monoplane FLY BABY; tie biplane can use a shock-absorbing gear. Be sure when adapting other gear that the wheels end up in exactly the same position as specified in the plans.

Bills of materials for the necessary sizes and quantities of raw materials are listed in each of the appropriate chapters in this plans book. Such items as wing spars, longerons, and rib cap strips can be ordered from a lumber mill or specialty house cut to the proper cross-section dimensions but not to the finished length without compromising the "amateur-built" requirement. The addresses of some suppliers are given in Chapter 9. Other sources can be found in the advertisements in SPORT AVIATION and the commercial magazines that feature homebuilt airplanes and recreational flying.

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THE PLANS

The method of presenting the plans for FLY BABY is quite different from the traditional "Roll of Blueprints" approach. Instead of a maze of full-size and meticulously dimensioned drawings, most items are presented in reduced scale with accompanying step-by-step pictorial and written instructions or a single convenient loose-leaf document. The isometric drawings are not always to true scale. In some cases, individual parts are drawn in over-size to emphasize a detail or an assembly method or undersize to avoid overlap or to fit into the available space. In such cases, the important dimensions are given.

In recognition of the fact that close tolerances are hard to work to, even without the usual home-workshop handicap of inexperience, sub-standard working area, and bare-minimum tooling, many structural items have been designed with the deliberate intention that their final dimensions be established by the procedure known as "Fit on Assembly". This eliminates wasted material and time-consuming rework when inaccuracies, which are not in themselves critical, prevent two mating parts from fitting together properly. Because of this concept, many of the parts are not dimensioned in as much detail as would ordinarily be expected.

The drawings also anticipate certain problems in the procurement of hardware and equipment. In many cases, sizes for sheet metal or tubular parts are a recommended minimum only. The airplane is of such a size that the weight penalty resulting from a change of metal thickness from 1/16" to 3/32" or even 1/8" on these parts is negligible. Therefore, it is not necessary to spend a lot of time and effort trying to locate material of the exact specified size when plenty or perfectly acceptable substitute material may be right at hand.

The same reasoning also applies to such "used hardware" items as fuel tanks, brakes, and brake master cylinders. Mechanical brakes are just as suitable as the hydraulic type used on the prototype FLY BABY. Since there are so many possible combinations of brakes and actuators it would be pointless to illustrate them all in the drawings. If the builder is too inexperienced in aircraft practice to determine acceptable part and material substitutions within the general intent of these drawings, he should, in the absence of experienced neighbors, consult a licensed airframe mechanic at the nearest airport or a Federal Aviation Agency Safety and Maintenance Inspector (under U.S. Gov't., Dept. of Transportation, in the telephone directory).

THE WORKING AREA AND CONDITIONS

Building an airplane is not a big job. It is a whole collection of little ones whose degree of simplicity or difficulty, independent of the builder's skill, is influenced to a large degree by the available work area and conditions. Airplanes similar to FLY BABY have been built in surprisingly illogical places, so it can be done without formal shop facilities.

However, suitable space where the work can be left standing is desirable. Since FLY BABY breaks down to components of convenient size, a standard one-car garage with a work bench across one end is suitable for the entire job. Minimum area for building the wing is enough to lay the 4-1/2 x 13 foot panel flat at a convenient working level and still allow room to work around each side and

the ends with space available for the standing tools. The fuselage is just over 14 feet long without the engine mount or rudder installed, and is two feet wide. Without the landing gear, the fuselage can be taken through a standard door located to permit a nearly straight approach to it. Depending on the relationships of various doors, this means that FLY BABY can be built in many rooms of a regular house and then be removed without knocking out a wall in the classic "boat-in-the-basement" tradition.

Since the Weldwood glue recommended for FLY BABY must be used at temperatures above 70 degrees Fahrenheit, and the application of dope to the fabric should also be done at this temperature, heat control in the working area is essential. Suitable glues are available for lower temperatures, but with no heat control the doping may have to be deferred until warm weather.

Doping should not be done in a confined area without adequate force ventilation anyhow, so unless a suitable shop is available, the job should be done outdoors in good weather or taken to another shop. Nothing will kill family approval of a home-built airplane project faster than a house full of dope fumes.

THE TOOLS

As with the working area, FLY BABY can be built with a bare minimum of tools but the job is greatly simplified by having a proper selection for the various jobs. Items marked with an asterisk (*) in the following list are considered absolutely essential. If these are not on hand in the home shop, material will have to be taken elsewhere for the necessary work. Aside from a suitable power saw and drill press the most essential tool will be an electric hand drill and an extension cord and light. This is because so much work will be done on and inside the airplane rather than on the bench as the job progresses.

SAWS

- Table or radial arm saw *
- Coping saw or jigsaw
- Bandsaw or bayonet saw with stand *
- Hacksaw *
- Small strongback saw or hand saw

DRILLS

- Bench drill or drill press *
- Electric hand drill *
- Drill bits to max. dia. 3/8" (with 1/4" shank for hand drill) *

FILES

- Suitable flat, rounded, and rat-tail files for wood and metal finishing *
- Coarse wood rasp
- Rotary file for electric drill
- Rotary rasp for electric drill (also called "Scotch Plane")

C-CLAMPS

Minimum 4 6-inch *

Minimum 2 dozen 3-inch *

WISE (steel) *

TACK HAMMER *

BENCH SANDING DISC

BENCH GRINDING WHEEL

BLOCK PLANES

SCREW DRIVERS *

TIN SNIPS *

DRAW KNIFE OR SPOKESHAVE

THREE FOOT CARPENTERS SQUARE *

6' STEEL MEASURING TAPE

SOLDERING IRON

PINKING SHEARS

WELDING RIG

SAW HORSES (2 minimum) *

GLUE BRUSHES *

PAPER CUPS (unwaxed 2 for glue and varnish) *

COLD CHISEL OR WIRE CUTTERS *

1/8" NICOPRESS *

BOX OR OPEN END WRENCHES TO 3/4" *

WORK PRACTICES

Many work hours can be saved and the various jobs simplified by organizing the work in an efficient manner. While circumstances will dictate different procedures for different people because of equipment, availability of materials, etc., a few time-saving suggestions can be followed by almost everyone:

CUT AS MANY PIECES OF A SIZE AS POSSIBLE AT ONE TIME. Much time is wasted in re-setting the tools (power saw, drill, etc.) when pieces are cut singly or a few at a time on an "as-needed" basis. Consideration must be given, however to the stipulation in F.A.A. Manual 18 that wood surfaces for gluing should not be exposed for more than 24 hours prior to gluing.

MIX GLUE WITH SPECIFIC JOBS IN MIND. Much expensive glue is wasted by mixing too much for a particular job. The "pot life" of Weldwood glue is only four hours, so it can't be saved for tomorrow. If quite a few items are to be glued over a fairly long continuous period, like an afternoon of installing wing rib corner blocks, plan on mixing several small batches during that time. Small batches are easier to mix and there is no question of approaching the pot life limit as the job goes on. Similarly, take precautions against running out of glue in the middle of a big and fast job such as laminating wing tip bows. Mix several small batches rather than one big one, or have a helper mixing new ones as you use the first.

The best applicator for Weldwood glue is a 1/2" to 3/4" paint brush. If the brush is washed out in hot water before the glue sets, the brush can last for months. Weldwood is cheaper in 5-pound cans, but constant opening of the can to take out small quantities ages it rapidly. It is best to buy it in small cans.

PLAN VARNISHING SO AS NOT TO BLOCK OTHER WORK. Try to save varnishing that will hold up other work in a particular area for the end of the work period so that it can dry overnight or between sessions. When wet varnish is on some parts while others are being worked on, be sure that shavings and chips don't fall on the varnish. Remember that dust from saws and grinders can float all over the shop and settle on a wet varnish job clear across the room from the tool.

Don't open the varnish can. Poke two nail holes on opposite sides of the lid and seal them with pieces of masking tape. Pull the tape and pour varnish into a paper cup for mixing with turpentine for small jobs. The can gets messy if varnish is poured over the lip, and after several openings for pouring small quantities, the varnish begins to thicken and scum over. Although cheaper by the gallon, it is best to buy varnish in quart cans. Be careful NOT to use WAXED cups for varnish, glue, or dope. "Hot cups" are fine, but not Styrofoam or plastic cups.

USE SYSTEMATIC WORK HABITS. Try to plan the work on individual jobs ahead for several days so as to have all the necessary material on hand and organize the most efficient sequence for doing things. Much time can be lost by wondering "what to do next?" and then figuring out how to go about it. Try to work on related jobs in sequence so that wood parts for several can be cut at one time, etc Try to set up specified times for working, with an ideal objective of being able to get some little thing, even if its only removing the clamps from yesterday's work, done every day.

AVOID OBSTACLES TO PROGRESS. One of the major roadblocks to completion of any home workshop project is objection by authoritative members of the family if legitimate family obligations and relationships are neglected for the project. This is a political matter beyond the scope of this technical document, but is nevertheless a major item for consideration. Other than the family situation, there are three major human causes of wasted time in construction projects:

- (1) The first is the eager friend who is anxious to be helpful but doesn't know anything about building airplanes or even handling tools. By the time you show him how, check his work; and generally do it over, you could have done it several times yourself in addition to the job you were working on. The exact and highly desirable opposite of this type, and unfortunately very rare, is the experienced person who can be handed a job and forgotten for a while as he gets it done with no fuss.
- (2) The second time-killer, more often plural than singular, is the curious and friendly type who drops around from time to time "to see how you are doing" and brings a friend along who has to have the whole project explained in detail from the very beginning. No work can be done at all during most of these visits, and the visitors are very seldom inclined or even qualified to help. A sub-category of this type is the one with whom a little knowledge is a dangerous thing, and who is always trying to improve your design to death by suggesting all sorts of things from little refinements to major rearrangements that will be made with YOUR time, money, and materials.

One unforeseen by-product of both categories of this second type is the added expense to the overall job resulting from the amount of your groceries, coffee, beer: etc., that they consume while sitting around keeping you from working.

- (3) The third major thief of your working time is yourself. As the plane begins to go together it is entirely too easy to gaze dreamily at it by the hour, admiring your own handiwork and engaging in all sorts of flights of fancy while sitting in the cockpit of an unfinished fuselage perched on a pair of sawhorses. Even if you don't feel particularly ambitious when you go out to the shop; or time is short, try to make sane tangible progress. Don't goof off for one whole work period by kidding yourself with the thought that you'll really bear down on it "tomorrow" or even "next week".

Overdoing the improvements can be a personal matter, too, although in some cases it stems from improving skill as the job progresses. There may be such a difference between the first few ribs you built and the last that you want to scrap the early ones and do them over. Your own standards and time/cost considerations will be your only guides here.

RECORDS AND PAPERWORK

Keep a record of all purchases of material for your FLY BABY, whether new or used. This will keep you informed of actual costs, will enable you to answer the inevitable question that you will hear hundreds of times: "How much did it cost ya, mister?", and will enable you to help friends who are considering a homebuilt and yourself when planning another. Most important of all, however, it will enable you to establish a true cash value for your machine when the tax assessor comes around. If he is not experienced in evaluating aircraft (some states tax airplanes as personal property while others use an excise tax) he may arbitrarily assign an unfairly high value. In the absence of substantiating figures. Also, sales slips can show that state sales taxes have been paid on the raw materials, another concern of the tax people when the plane is finished.

Try, too, to keep at least a rough check on your working time. The next-most-asked question from the spectators is: "How long did it take you to build it?" There is satisfaction in being able to snap off a concise and authoritative answer, either in terms of man-hours or days, weeks, and months.

It is a very good idea to start the airplane logbook at the time you start construction. Information as to the source and grade of raw materials can form a valuable historical record, and a record can be kept of essential pre-finish FAA inspections. Since a homebuilt is not pinned down to an approved bill of materials that is a matter of record as in the case of type-certificated production models, a record should be included of the type of covering material, type of dope whether nitrate or butyrate, and even the type of hydraulic fluid used in the brakes. You may forget over subsequent years, or a new owner not know at all if it isn't recorded, with a resulting complication of maintenance problems.

Other paperwork directly concerned with registration and certification of your airplane is covered in Chapter 8, ASSEMBLY, TEST, AND FLYING.

CONSTRUCTION PROCEDURES

Those who are generally familiar with aircraft construction and repair procedures should have no trouble at all in any phase of building FLY BABY. Those unfamiliar with aircraft practice, or skilled only in one specialized field, should consult their more experienced friends before proceeding. In any case, it is strongly recommended that anyone building FLY BABY or any other homebuilt airplane obtain a copy of Federal Aviation Agency Manual 18, MAINTENANCE, REPAIR AND ALTERATION OF AIR FRAMES, PROPELLORS, AND APPLIANCES, available from the Government Printing Office, Washington 25, D.C., or some aircraft supply stores for \$1.50. This book is "The Bible" on all phases of aircraft construction and repair procedure. *

It is impossible to detail fabrication procedures down to the fundamental level of how to hold the hammer. The drawings and instruction pre-suppose a competent skill level. There are, however, certain construction procedures associated with aircraft standards of quality that should be mentioned.

WOOD

Wood aircraft construction differs considerably from traditional cabinet and furniture-making procedure. There are no mortises, tenons, or dovetail joints in aircraft. All wood-to-wood joints are by glue in shear or by bolting. Bolt heads or nuts bearing against bare wood opposite a metal fitting should be backed up by large-diameter wood washers. Wood screws are never used for joining; small nails are used to hold glue joints under pressure while drying and then become entirely redundant. Wood surfaces are protected from damage during clamping by use of clamping backup blocks to distribute the load.

With the exception of the wing spars and the slotted rib cap strips, it is much cheaper for the builder to buy his spruce lumber in planks and saw it to size himself than to have it finished at a mill. The cap strips can be cut from standard 1/4" "Cap Strip Stock" on any circular saw, but cutting the 1/8" x 1/8" slot calls for exactly the right size blade. A "planer" blade should be used for finished rip cuts on all non-plywood wooden parts in FLY BABY. Suppliers of aircraft grade wood that advertise in SPORT AVIATION, magazine of the Experimental Aircraft Association (EAA) have been advised of the size and quantity of the FLY BABY materials, and will be able to make "package" deals at fixed prices.

METAL

while there is very little metal in FLY BABY, certain practices must be observed. Most of the S.A.E. 4130 sheet steel fittings can be bent cold by hammering in a vise. However, the jaws should have a slight radius to prevent serious weakening of the metal at the outside of the bend. Rounding off the corners of metal parts is not necessary, but is a matter of craftsmanship. ALL metal parts should be protected against corrosion by suitable painting, either with Zinc Chromate Primer or a rust inhibitor like Rustoleum. The best method is to have them cadmium plated.

* Out of print. Now sold by EAA along with many other "How-to-do" books.

MISCELLANEOUS HARDWARE

The nuts and bolts are called out in the bills of materials, or parts lists, by the "AN" number, meaning Army-Navy standard. These can be ordered from aircraft stores or mail-order houses by the numbers, which have easily identified meanings. An AN-3-7A bolt is 3/16" in diameter as indicated by the first number, which varies by sixteenths of an inch. The second number indicates the length, the distance from under the head to the far end of the threads in eighths of an inch. However, 8/8 do not make an inch in this case. An AN-4-10 is a 1/4" bolt one inch long and an AN-5-11 is a 5/16" bolt 1-1/8" long, and so on. The letter "A" on the end of the number means the bolt is NOT drilled for a cotter pin. With no letter, it's drilled. All bolts used in FLY BABY are cadmium-plated steel.

In aircraft installation, it is customary, but not mandatory, to install bolts with the heads pointing either forward relative to the airplane, outboard or upwards. Where bolts through wood in FLY BABY are loaded in shear, the area of the bolt is enough so that the hole doesn't have to be bushed. The only bushings actually required are for protection in wear areas, as where wing, attach bolts are frequently inserted and removed. When installing wide wood washers under nuts or bolt heads that bear on wood, be sure to varnish the wood UNDER the washer before installing it permanently. Except where specifically indicated, all nuts used in FLY BABY are AN-365 type elastic stop nuts. Likewise, moving metal parts are joined by clevis pins secured with cotter pins except as noted. Washers should be used between the cotter pin and the metal surface.

The 1600-pound-minimum strength turnbuckles are secured on the fork, end by clevis pins while the wires through the eye are reinforced with AN-100-4 thimbles and secured with 1/8" Nico sleeves. By using the same size of wire all over the airplane, the wire purchase and fastening problems are simplified. It should not be necessary to buy a 1/8" Nicopress tool (they cost about \$22.00), for many mechanics and most aircraft repair shops have them. Turnbuckles are safetied by either single or double wrap with #41 safety wire per Manual 18.

When buying nuts and bolts, washers, cotter pins, etc., don't get just the exact number specified by the parts lists. No one ever has too many of these items. For AN-3 bolts and AN-393 clevis pins especially, buy a good variety of lengths between the longest and shortest specified. No one ever seem to have a surplus of AN-960-10 washers on hand, either.

A SUGGESTION

If you are completely inexperienced in aircraft matters, it is suggested that you associate yourself with a local chapter of the Experimental Aircraft Association (EAA), a national organization devoted to amateur aircraft builders. Write to Headquarters, EAA, 3000 Poberezny boulevard, Oshkosh, Wisconsin, 54903-3086. Membership is \$35.00 per year, and worth every cent of it for the magazine SPORT AVIATION alone. Write to EAA for the address of the chapter nearest you. Practically all of the items you will need to build your FLY BABY are advertised in the pages of SPORT AVIATION.

ENOUGH OF GENERALITIES! GET TO WORK ON YOUR FLY BABY!

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