MODELS FOR TEST AND DESIGNING HOMEBUILT AIRCRAFT . . .

by ***Molt Taylor***
P. O. Box 1171
Longview, WA 98632

and

Jerry Holcomb
1010 NE 122nd Ave.
Vancouver, WA 98683

Photo Courtesy Jerry Holcomb

Jerry Holcomb, right, and Noel Martin prepare the model of the original configuration of the Lear-Fan for its first flight. Its subsequent crash revealed the need for a different tail configuration . . . which, ultimately, was a "Y" shape.

Jerry Holcomb

An electric powered 1/6th scale model of a design by Tom Moore of Danville, CA called the Laminaire. A full size prototype is under construction.

Jerry Holcomb

A 1/6th scale model of the proposed Wheeler Aircraft "Alaskan" 4-place amphibian.

One of the most practical ways to evaluate any aircraft design is to build an accurate model and test it in a variety of ways. Test procedures can be very simple or extremely sophisticated, depending on what you want to find out about the design. This process can be applied to the most complicated types of aircraft and to simpler homebuilt designs, too. Model testing can be used to evaluate handling qualities, control effectiveness, stability, maneuverability and even some performance parameters. Models can be useful in studying structural adequacies, engine locations, propeller problems, noise and vibration. In fact, models can be built to evaluate just about anything that you want to know about an aircraft. The trick is to know what you want to find out and then to build an appropriate model, with the proper instrumentation, at the proper scale and with suitable provisions to get the information you want at the least cost and complication. If all you want to find out is whether a given design will fly at all, it is not necesary to build an expensive wind tunnel model; maybe a simple hand launched profile scale model will show all you want to know.

The next step could involve testing a simple, relatively inexpensive, radio controlled model. Properly executed scale weight distribution, scale control and evaluated, this will show if you need to look at some design features more closely. Things like control adequacy, or perhaps stability during unusual conditions will be evident in this sort of model. Regardless of the model program's success (it may crash), it is far less costly and time consuming to perform these tests with a model than to perform them with a full size machine!

Models can be built at almost any scale and still give some usable information. A very small scale hand launched gliding model may be adequate to show the general stability characteristics of a configuration, whereas a quarter scale model with surfaces, and perhaps even a scale thrust powerplant can quite accurately reflect full sized performance and general handling qualities. If a design happens to be of a seaplane, a suitable model can give excellent projections of water stability, handling and spray patterns long before you could ever find out with a full size example, and certainly at far less cost. It all gets back to knowing what you want to find out, and then building a suitable model with the least cost and complication possible.

Model Details and Complications

Just any old model is not suitable for these kinds of investigations. The model should be reasonably accurate and to some exact scale. It is also important to try to build the model as lightweight as possible while retaining sufficient strength. Weight is very important when it comes to trying to make a model that will actually fly. Wind tunnel models are often built out of solid materials like hardwood or metal, whereas models intended for flight are usually built from balsa wood, and even fiberglass composite. It is important that models intended for flight be carefully balanced so that their center-of-gravity is in the proper place, and if at all possible that they have proper moments of inertia. This means that their weight is distributed like the full sized version. This can be difficult if, for example, the design has a drive shaft driven remote propeller.

It is essential that the model be reasonably symmetrical and have a smooth surface finish. A model with rough and inaccurate surfaces will not give very good results. Flight control surfaces should closely approximate those of the original design in their location, deflection and area. Hinge lines should be similar to those of the original design. It is best to build any test model as light as practical and make provisions for ballasting to bring the model up to scale weight after it has been initially test flown and debugged. Such ballasting also permits moving the center of gravity as needed once the model has been initially trimmed.

Scale Weight

Scale weight is a feature that is often overlooked. A good way to think about scale weight is to consider a simple one square inch cube. If the cube represents a half scale model, then the original would be two inches high, two inches wide and two inches deep. Thus it would weigh four times as much. If the cube were a one third scale model, it follows that the original was three inches high, three inches wide and three inches deep. It would weigh nine times as much. We can thus see that scale weight is the cube root of the scale of the model times the full sized weight.

Models

Molt's experience with radio controlled models goes back to the early days of WW-II when he was in charge of Pilotless Aircraft Development at the Naval Aircraft Factory in Philadelphia. Not only was he involved with the development of new concepts, but he also tested, by R/C, some contemporary designs such as the F6F, F4U and other Navy aircraft. More recent experience includes early development of the Lear-Fan, which, though it has yet to gain full FAA Certification, has proven to be an excellent performer. Its failure to receive final certification has had nothing to do with its flight qualities, but has been a matter of test procedures and new requirements which were dictated by its new and unique structure. For the Lear-Fan, Jerry initially built a small hand launched profile glider model which quickly showed that the original anheadral (inverted V) tail would not be satisfactory when used with a low wing configuration. Depressed flaps tended to interfere with the tail's effectiveness and this was confirmed with a one-eighth scale radio controlled model quite dramatically, when it crashed on take-off. Jerry then built a new one-tenth scale radio controlled model that could be fitted with several different tail configurations. This model flew and handled quite well. The final "Y-tail" configuration was etablished as a result of the RC model work, and more precise tests were later done with wind tunnel models. The radio controlled model work proved very beneficial to the early Lear-Fan program. A program that involved early radio controlled model was the Coot amphibian homebuilt design. Here, a one quarter scale model was built to perfect the hull underwater configuration and to confirm the design and placement of the "float wing" configuration. Other model projects that Molt and Jerry have developed include a four-place version of the Mini-Imp, a Formula One racer with a tail propeller, the Laminaire two-place design and the Alaskan amphibian. Each of these designs has been subjected to complete radio controlled flight investigations which often resulted in modifications before actual construction of full scale prototypes started. Subsequent flight evaluations of full scale versions confirm that the model studies were worthwhile, and were valuable time and expense savers. Anyone interested in pursuing the use of models in the development of their own design may contact the authors. We have considerable experience and can assist other builders/designers by building and testing your new ideas in model form.

RC Scale Models . . . the poor man's wind tunnel

Models — Suitable Control Systems

Fortunately, radio control systems adequate for most model flight testing are inexpensive and readily available. Suitable servos are available to move the flight control surfaces of even very large scale models as well as to actuate auxillary functions like retractable landing gears, flaps, trim devices or just about anything else you may want to incorporate. **Experienced** radio control model pilots have developed skills which permit them to duplicate any flight maneuver that can be done with a full size piloted aircraft, and the model pilot has an advantage because he does not have to ride in the aircraft. Thus the model pilot can accomplish maneuvers that could not be safely duplicated by a live pilot. It is possible to far exceed the limits which would apply to the full size aircraft. It is entirely practical to evaluate characteristics such as spin entry and recovery techniques without subjecting a live pilot to danger. Things like stablity can be directly observed as can stalls and recoveries. By flying the radio controlled model from a moving truck or boat, it is possible to get accurate values for the model's speed while in flight, and both high and low speed flight conditions can be closely observed.

It is essential that the person performing the radio controlled piloting know exactly what he is doing and not just be flinging the model about the sky as is often done by many recreational model flyers. There is far more to flight testing a radio controlled model than just getting it off the ground. The whole procedure should be accomplished with the same precision and procedure as testing a full size example if the test operation is to be meaningful. A good record should be kept, and if at all possible a video tape made of the entire operation for future reference. Properly done, a good model investigation can be a valuable first step in the development of an aircraft design, particularly if the configuration is something new and different.