PEARSE MONOPLANE IN QUARTER SCALE

BY IVAN PETTIGREW

CONSTRUCTION NOTES

2003

Before starting construction some decisions need to be made regarding the wing. It could be built in one piece, but it is not easy to remove the wing from the rest of the model, and it would be rather bulky for transportation. The plan shows double ribs at the point where the elevator ends and the ailerons start. The prototype was built with the outer wing panels being removable at this point. The model is easily transported in this way. The outer panels are held in place with a nylon snap fastener on the underside of the wing. To remove a wing panel, disconnect the snap fastener and clevis at the aileron horn and remove the outer panel. No tools are necessary for wing assembly.

Another decision regards the ailerons. This model was built with conventional ailerons. These are shown on the plan. However the original Pearse Monoplane had inset square ailerons in the location shown on the plan. These have not been tried in the model, but should work if they are activated like spoilers with the movement being upwards only. They could possibly be activated like ailerons with extreme differential that go up quite a bit, but hardly any distance down.

Downward movement would add considerable drag and result in unwanted adverse yaw. The third option is to fly “rudder only” with no ailerons. A smaller park flyer version of the Pearse Monoplane was built to fly rudder only, and performed very well without ailerons. It did not need to have dihedral as is normally used on models without ailerons. There is a natural correcting force because of the battery being located down below, and fin up high. If a wing drops, the resulting sideslip is corrected by the pendulum effect of the battery (body weight in the real plane) and opposing air force on the high mounted fin. Hence when the model is flown without ailerons, it is perfectly coordinated during turns. It could almost be said that for normal turns it should be flown more with rudder than with aileron. The greatest disadvantage of flying without ailerons is experienced in taking off and landing with a cross wind. The high mounted fin tends to catch any cross wind component and cause the model to do the “tricycle thing.” Ailerons can be used to correct this, but it is best to take off and land as directly into wind as possible.

The framework (dare we call it a fuselage) in built up from regular ¼ inch dowel. For strength at the joints, it is best to use epoxy to glue the different sections together. The wire undercarriage is attached by binding thread and covering with carpenter glue. The nosewheel does not steer, and needs to be softly sprung. Make certain there is plenty of wheel clearance for the nosewheel. Should the model land on the nose wheel first (a “No! No!” with this plane) the nosewheel will lock up if it touches the bottom of the battery platform. This sudden braking of the nosewheel needs to be avoided at all cost.

The major difference with the wing construction is that the spar is one solid piece. The wing ribs are cut where the spar is located. The nose ribs are butt glued to the front of the spar and the aft part of the ribs to the rear of the spar. Start construction by making the spar as shown on the plan. Cut the outline from 1/8 sheet balsa, then glue the hardwood strips in place as indicated. These

may be spruce or basswood. If the wing is being built in three sections, the spar will be cut at the point where the outer wing panels join, and then “tongue and box” joints built for the spars before proceeding with the rest of the wing construction.

Start assembling the wing with the spar in place over the plan, then glue the aft section of the ribs in place and attach the trailing edge and aileron spars. Next attach the nose ribs and the 3/16 inch balsa strip that forms the first part of the leading edge. Next attach the sheet covering to the lower surface of the wing from the leading edge to the spar. The wing at this point will seem rather floppy, but after attaching the sheeting to the corresponding upper surface it will be very rigid and not easily twisted. Hence, to avoid a nasty warp in the wing, it is very important that it be weighted down to a flat surface while the sheeting is attached to upper surface from the leading edge to the main spar. After applying the sheet covering to the upper surface, complete the leading edge by gluing the 5/16 inch strip in place and shaping to the correct contour.
Points to note during assembly of the model are the upthrust and location of the Centre of Gravity. Also check that when the model sits on the ground the wing has a slight angle of attack as shown on the plans. If making a mock up of the pilot, keep it rather slim. It is amazing how much drag the pilot adds to the model in flight.

FLYING
Take off is just as for any other model, but should be done as much as possible into wind. If there is a cross wind component, use aileron into wind to compensate for the tendency of the wind to blow the model over sideways because of that high fin. Normal flight is again just as for most other models but remember to use the rudder. Before landing the first time, do some slow flying at about half power. This model is typical of planes with low aspect wings and will fly at a very high angle of attack without stalling. It can be flown slowly in a nose up attitude without any danger of a tip stall.

The difference in flight characteristics comes when it is time to land. A low aspect ratio wing like this is at the opposite end of the scale from a sailplane. The Pearse Monoplane is NOT a good glider. Be sure to land before the power runs out. By all means try some power off glides to see how steeply the model comes down, but don’t approach to land like this for the first landing. Make the landing approach somewhat flatter by keeping on some power and it is best to keep this power on through the flare and landing. Before touch down, hold off the runway as long as possible so that the model is getting into that slow flight, nose up attitude, and touches down on the rear wheels. If the model touches down on the nose wheel first it is because it has not been slowed down enough. If this happens it will pitch up suddenly and “porpoise” wildly several times. If the battery ever runs low in flight and the motor cuts out, keep up a lot of speed in the glide so that there is sufficient time and elevator control to flare and land, but the descent angle will be very steep and the landing hard to judge. Keep it safe and don’t stretch the flight time. This kind of wing is not really efficient, so flight time may be shorter than for conventional models.

The Pearse flyer has its own bag of tricks. The thing it does amazingly well is the outside loop. Usually the last sector of an outside loop is the hardest part to complete, but the Pearse design has everything going for it in this regard. When struggling up on the last part of an outside loop,

the thrust of the motor upwards and weight of the battery downwards results in a “couple” that brings the model back over into level flight without any problem. The design doesn’t work that well for a normal loop, but it can be done if the model builds up speed in a dive first. If the model gets too slow at the top of the loop it tends to want to continue in inverted flight. This is corrected by reducing power. Aileron rolls are a breeze with the kind of ailerons shown on the plan. Spins are impossible, so it is perfectly safe to break all the rules and fly “low and slow.” If there is a tendency for the model to pitch up when power is reduced for descending such as in the approach to land, it is because there is insufficient up thrust or the Centre of Gravity is not sufficiently forward. That was a problem encountered with the smaller model that was built first. Otherwise all three models have been very successful flyers and have flown extensively with out any major problems. The only damage that has been sustained has resulted from heavy landings during the learning period.

Further information on the original Pearse Monoplane can be found by doing a search on the web for Richard Pearse. Good luck with your model of his flying machine.

The 1903 Pearse monoplane

by Ivan Pettigrew - written 2005

One hundred and two years ago in the land down under, an innovative young man by the name of Richard Pearse was doing experiments with a machine which he believed would fulfilL his dream. For some years he had been building bicycles and motor bikes, but his ultimate goal was to make a flying machine. He lived alone on his farm in the South Island of New Zealand near the city of Timaru. My mother was eight years old at the time, and lived in the area. She often told me the wild stories that circulated about this man, but many of them were speculative because of his secretive nature.

Many aviation historians now believe that Pearse got his machine off the ground on March 31, 1903. However, his flying field was surrounded by fences of unkept gorse. In places it rose to over 12 feet. It his said that his first take offs invariably ended up with him flying into a gorse fence, this being rather akin to ending in a clump of wild blackberries. The veil of secrecy was lifted each time that he had to enlist the help of local boys to salvage his plane from the top of a gorse hedge. Finally he moved to a new field on a terrace overlooking a river with a wide river bed. It is said that he flew out over the river for a minute or so, but the engine lost power with overheating and the craft came down suddenly on a gravel bar. Souvenir hunters were picking up pieces of the engine and airframe for some months afterwards, and some of these pieces are in aviation museums today. It is said that his flights were not recognized because he never achieved a controlled landing. Pearse went on to build two more aircraft of different designs, but I don't believe that they were as successful as his first one. A search on the web for "Richard Pearse" will bring an amazing number of responses.

Pearse was well ahead of the times in many ways. He built a monoplane instead of a biplane, he designed his craft with a tricycle landing gear and steerable nose wheel, he used a form of ailerons instead of wing warp, and bolted the propeller directly to the crankshaft of the engine, thus avoiding the weight of a heavy flywheel which is necessary when powering the propeller with chain drive. The sub frame, (it can hardly be called a fuselage) was completely triangulated,

thus making for maximum strength, even when built from light material. The engine itself is an engineering feat in itself. A functioning engine has been built in recent years and is installed in a full size replica of the Pearse monoplane. The engine is a two cylinder opposed design, but the pistons are "double acting" as were many of the steam engines of the era. In other words, in addition the normal spark plug and valves located in the cylinder head at the outboard end of the cylinder, an additional spark plug and pair of valves were located at the inboard end of the cylinder. The cylinders fired on one of the outbound strokes as well as on the conventional inbound one.

Although I now live in Western Canada, I keep in touch with many friends in the aviation community in the Timara area where I grew up. In recent years I had been hearing from them of the increasing interest in Richard Pearse, and the plans that were developing for a major celebration of flight to mark the 100th anniversary of his first take off. From several years ago, I had a very good drawing of the Pearse craft. From this I drew up plans for a small park flyer, thinking that if this weird thing actually flew, I would build a larger model. It is virtually a flying wing, but I have observed that most flying wings have swept back tapered wings. I didn't know if it would be possible to control a flying wing that had the planform of a barn door. With a little reading on the subject, I found that a barn door would fly if it had a very low aspect ratio. Researchers have found that the optimum ratio is 3:1. At this point I had found that Richard Pearse built his craft with a span of 21 feet and chord of 7 feet. The ratio is exactly 3:1. Where did he get his information? The little park flyer that I built was capable of taking off and flying in an acceptable manner right from the start, but with modifications and refinements here and there it was soon very well mannered, and really quite fun to fly. At first it had a Speed 280 motor, but performance was enhanced greatly by going to a GWS geared Speed 370. Flight endurance is over ten minutes. The 8 cell 700 mAh NiMH battery is located quite low under the pilot's feet. The weight of the battery in this location, combined with the high thrust line, results in a couple which makes 'outside' loops much easier to perform than normal ones. Doing three of these in succession is quite addictive.

After flying this park flyer for several months, a friend in New Zealand sent me a three-view drawing of the original design and I drew up plans for a one-quarter scale model which I refer to as Richard II. It is powered by a 22-turn Magnetic Mayhem racing car motor incorporated with a Master Airscrew gearbox, running off nine CP1700 SCR cells. It is a very predictable flyer and easier to control in windy conditions than the smaller model. I made the wing of this model in three sections, each one 20 inches square. The airframe was screwed together so that the model could be completely taken apart and fitted into a square box that conformed to the size that could be taken as passenger baggage on the airlines. There was space left over when the model was packed, so I made another small park flyer, but with the wing in sections so that it would go in the box together with the larger model. This model was named Richard III. Because the earlier models were so stable, I built this one without ailerons. It flies very well, the only drawback to lack of ailerons being the inability to handle much cross wind on take off and landing. Neither will it do aileron rolls which the others do with ease.

In mid March I made my way to New Zealand and had a wonderful vacation visiting family members and friends in different parts of the country. I was invited to speak about Richard

Pearse at several schools in my home area and also did flight demonstrations with the models. A repeat performance was called for at one of the schools so that the National TV team could capture the act. Two of the schools I visited had students attending who were great-great-nephews of the original Richard Pearse. Since their grandfather, Richard Pearse, (a nephew of the first Richard) was not able to attend either of these functions, I did a special flight demo for him at the local model flying field which is located on an abandoned airfield where I used to fly models with my high school friends during WW II.

At the end of the month I attended the air pageant help in Timaru to mark the one hundredth anniversary of the Richard Pearse flight attempts. The full scale replica was of course on display, and for the final act of the program it was wheeled out on a taxi way in front of some of the vintage planes and war birds in attendance. The engine was run up with its abundance of noise and vibration from those double acting pistons, and that was the prearranged signal for me to take off with the quarter scale model and give a flight demonstration. If seeing is believing, we hope that we made believers out of some of those critics who didn't think that it was ever possible that the Richard Pearse design could be made into a controllable flying machine.

Ivan with Richard Pearse, a nephew of the original Richard. This Richard still lives in Timaru.

Flying at the air show

Flying in the school yard. Jeff Pearse, great nephew of Richard Pearse, and Henry Pearse, great great nephew of Richard. This was at Henry's school where, as a young teacher, Ivan taught some Pearse relatives 50 years ago.