CONTROL LINE MODEL AEROPLANE

Doc. **A4CL1/3** Date: 29 July 2003

This document is based on information contained in "The complete Book of Building and Flying Model Airplanes" by Walter A. Musciano, Prentice Hall Press, ISBN 0-13-156068-9.

BASIC TRAINER

Building Instructions

Language Usage

This document is written in English. One day Mrs Gates' little boy, William, may learn that there is no such thing as US English. There is English and there is American.

Before You Begin

It is important that you read all these instructions and study all the plans carefully before you commence construction. You need to have a thorough understanding of how the model is going to be built before you even start. It is also recommended that you read "Tools, Materials, Tips & Tricks".

Design

General Particulars:

Wing Span	600mm (24")
Length (excluding motor)	475mm (18.7")
Mass (approx.)	600g (1lb 5oz)
Wing Area	672cm^2 (108in^2)
Wing Load (approx.)	0.900g/cm^2 (1.75lb/ft^2)
Engine	1.8cc (0.10cu.in) to 3.5cc (0.20cu.in)

High strength, simple construction, and ease of operation are the three basic requisites for a C/L trainer model, and this one meets all three.

High strength is of the utmost importance because the tyro is fairly certain to make at least one error during the first few flights, and rugged construction will help to withstand rough landings, nose overs, and other mild mishaps. Solid construction is the best method of achieving maximum strength. A solid flying model can absorb numerous dents and scratches and still remain in flying condition well after a built-up model has had to be retired.

Simplicity of construction is reflected not only by the solid construction but by the profile fuselage and one-piece engine mounts. A profile fuselage offers the illusion of a conventional type when in the air and on the ground, except when viewed from the top. One-piece engine mounts, when cut out carefully, are pre-aligned and fit the engine and fuselage automatically.

Ease of operation is absolutely essential for the novice, and this has been taken into consideration in the configuration of the design. A beginner's trainer must be easy to handle but must give the "feel" of flying.

One of the most important factors in establishing the sensitivity of a C/L model plane is the position of the balance point. If this point is too far back, the controls will be sensitive, and the model will react suddenly to the slightest control-handle movement – a factor that could spell disaster for the inexperienced flyer.

Another factor that governs the sensitivity of the controls is the area of the elevator. Manoeuvrability will increase as the elevator area increases.

Materials

These are the minimum material requirements for building the control line trainer.

No. Req'd	Description
1	12mm x 75mm x 900mm (1/2: x 3" x 36") medium balsa for wing
1	12mm x 75mm x 450mm (1/2: x 3" x 18") hard balsa for fuselage
1	3mm x 75mm X 600mm (1/8" x 3" x 24") hard balsa for elevator and stabiliser
1	3mm x 150mm x 300mm (1/8" x 6" x 12") plywood for bell-crank mount, fuselage doublers, fin and wing tip end plates
1	12mm x 12mm x 450mm (1/2" x 1/2" x 18") hardwood for engine mount
1	2.5mm (3/32") diameter x 450mm (18") piano wire for landing gear
1	1.5mm (1/16") diameter x 450mm (18") piano wire for control rod
1	0.5mm (0.02") diameter x 750mm (30") piano wire for lead outs
1	M20 (3/4") steel washer wing tip mass
1	20mm (3/4") nylon control horn with securing nuts ("Du-Bro" No. 107 [2 per pack] or similar)
4	11mm x 28mm (7/16" x 1-1/8") nylon hinges ("Du-Bro" No. 118 [6 per pack] or similar)
2	50mm (2") diameter main wheels ("Du-Bro" No. 2.00T [2 per pack] or similar)
1	20mm (3/4") diameter tail wheel ("Du-Bro" No. 75TW [1 per pack] or similar)
2	3mm (1/8") diameter x 25mm (1") steel hook (or "J") bolts (preferred) OR 3mm (1/8") nylon landing gear straps with suitable securing screws ("Du-Bro" No. 238 [2 per pack] or similar) for securing landing gear wire to fuselage
3	2.3mm (3/32") diameter wheel collars ("Du-Bro" No. 138 (4 per pack) or similar)
1	1.8cc (0.10cu.in) to 3.5cc (0.20cu.in) glow-plug control-line model aeroplane engine (2.5cc (0.15cu.in) with remote needle valve recommended)
1	propeller to suit engine (get more than one, you will break them)
4	engine securing bolts to suit with nuts, washers, and spring washers
1	50mm (2") nylon or aluminium control-line bell crank with mounting bolt, washers and nut
1	45ml (1.5fl.oz) fuel tank with securing strap ("ACME" B-2 or similar)
1	118ml (4fl.oz) 15 minutes or 30 minute aliphatic resin glue ("Pacer" Z-Poxy or similar)
1	50ml ((2fl.oz) balsa cement (cyano-acetate)
1	250ml (10fl.oz) fuel-proof model aircraft dope
1	sheet of model aircraft tissue paper (Silkspan or similar)
3	3mm (1/8") steel washers for wheel spacers
2	6G x 10mm (3/8") pan head (preferred) or round head brass (or stainless steel) wood screws
1	1.6mm (1/16") ID x 600mm (24") fuel tubing for glow-plug fuel ("Du-Bro" No. 221 or similar)
1	control line handle
1	2-line 0.4mm x 12m to 15m (0.015" x 40' to 50') braided stainless steel control line kit with securing clips ("Brodak" BH-658 or similar)
1	1.5V heavy duty starter battery
1	glow-plug lead
1	fuel squeeze bottle

No. Req'd	Description
1	bottle of fuel suitable for the engine
1	starter (or "chicken") stick to start the engine

Other optional materials are-

No. Req'd	Description
1	38mm (1-1/2") diameter propeller spinner colour to suit ("Du-Bro" No. 260 (white), 261 (black), 262 (red), 263 (yellow), or 264 (blue) or similar); this increases the efficiency of the propeller
1	2-56 threaded ball link ("Du-Bro" No. 181 or similar) with 2-56 threaded coupler for 1.6mm (1/16") diameter wire ("Du-Bro" No. 111 (2 per pack) or similar) for connecting control rod to control horn
1	225ml (8fl.oz) balsa tint super light filler ("Dave Patrick's" Model Magic or similar), great for fixing those little mistakes and providing fillets at the wing and tail roots
1	12V electric engine starter with battery (an expensive luxury item not normally required)
	Decals to suit
	Fuel proof paint (colours to suit)

All of the wood, piano wire, glues, paint, and dope should be readily available from your local hobby shop. Make sure the engine is suitable for a control line aeroplane. Most engines today come fitted for radio control aeroplanes; they need modification for control line use. Much of the other hardware may be difficult to obtain as C/L aeroplane models are not that well catered for. For any "hard-to-get" materials or parts, TCI Hobbies Inc. is recommended. Visit their web site. They specialise in C/L model aeroplanes and are most helpful with advice. Their contact details are-

TCI Hobbies Inc.

721"E" Street
PO Box 370
Hawthorne, Nevada 89415

USA

Ph: + 1 775.945.1515

Fax: + 1 775.945.1516

E-mail: info@ucontrolmodels.com

URL: www.ucontrolmodels.com

TCI Hobbies have an excellent mail order service with delivery world-wide generally within one to two weeks. Even with postage and insurance, the cost is about the same as you would pay in your local hobby shop.

Fuselage Construction

Begin construction with the fuselage (see Doc. No. A1CL1/1 [Parts Details]). Transfer the shape of the fuselage profile from the plan onto the 12mm x 75mm x 450mm (1/2: x 3" x 18") hard balsa. This can be done by either drawing the shape on the balsa from the dimensions given on the plan or using "pencil" carbon paper between the plan and the balsa and tracing around the shape of the fuselage. This should include the opening for the wing and landing gear. Be certain that the bottom of the wing cut-out and stabiliser platform is in perfect alignment with each other, that is, parallel. Cut the fuselage to shape with a coping saw. The cockpit on the top of the fuselage is cut out separately and glued to the fuselage using balsa cement.

Do not cut out the landing gear slot in the balsa.

The wing opening is made by first drilling a 5mm (3/16”) or 6mm (1/4”) diameter hole anywhere within the opening. Then remove the blade from the coping-saw frame and slip the blade through the hole. Reassemble the saw and proceed to cut the opening for the wing. When complete, remove the blade from the frame, take it out of the opening, and again reassemble the saw. The two plywood reinforcement pieces are now drawn or traced and cut to shape (including the landing gear slot) with the coping saw.

Apply epoxy glue to the plywood pieces and where they mate with the fuselage and press them against the side of the fuselage in the proper location. Slide the plywood back and forth a little to evenly distribute the glue. While this is drying, the landing gear (L/G) can be bent to shape (see Drg No. A1CL1/1 [Parts Details]).

You will be surprised to discover how tough the spring steel piano wire is. It must be bent with pliers, and they must be gripped very firmly so they won’t slip off the wire. Although tough, the wire can not be bent more than twice, or, because of its very toughness, it will break, A vice and small hammer can help bending. Once the landing gear has been bent to shape, remove the excess wire with the wire cutters incorporated in the priers.

While the fuselage is drying, cut the plywood L/G securing piece. After the fuselage has dried at least 30 minutes, cut the L/G slot in the balsa using the coping saw. This slot should be just wide enough to take the plywood L/G securing piece. Slide the L/G into the L/G slot and glue the plywood L/G securing piece into the slot using epoxy glue. Be careful that the landing gear is set at the correct angle as shown on Drg No. A1CL1/2 [General Arrangement] while the epoxy glue sets. Once it is set, the L/G may not be able to be rotated in the fuselage.

After the plywood L/G securing piece has dried (at least 30 minutes), trim the fuselage with a sharp knife – similar to an X-Acto No. 26 blade – and rub with fine sandpaper until all edges are attractively rounded. Do not round the wing opening or the stabiliser platform. Secure the landing gear to the fuselage using hook bolts (or nylon retaining straps) as shown on Drg No. A1CL1/2 [General Arrangement]. If straps are used, you will find they are slightly oversize being for 3mm (1/8”) diameter wire. To fix this, apply a little epoxy glue into the slot of the retaining straps before they are screwed into position. This glue will dry and form the proper shape for the 2.4mm (3/32”) diameter wire.

The engine mount is made by first cutting the 12mm x 12mm x 450mm (1/2” x 1/2” x 18”) hardwood into four length each 100mm (4”) long. These four pieces are than glued together side-by-side using epoxy glue to form a piece 48mm x 12mm x 100mm (2” x 1/2” x 4”). Once the glue has dried at least 30 minutes, rub both the top and bottom surfaces of the engine mount smooth with medium sandpaper. Cut the engine mount to shape as shown on Doc. No. A1CL1/1 [Parts Details]. Remember that in every case the engine to be used governs the width of the engine mount opening. Engine dimensions vary, so it is wise to have the engine on hand or to know its dimensions while your aeroplane is under construction.

Position the engine mount into the nose of the fuselage. Place the fuel tank into position and mark the centre of the hole for the fuel tank breather (the bottom tube). Remove the tank and engine mount. Drill a 6.5mm (1/4”) diameter hole through the engine mount for the fuel tank breather.

Sand the mount smooth and glue into the nose of the fuselage using epoxy glue. Align the engine mount with the bottom line of the wing opening; it is imperative that they be parallel. Set the fuselage aside to dry.

Tail

Draw or trace and cut to shape the stabiliser and elevator from the 3mm (1/8”) balsa using a single-edge razor blade or modeller’s knife (see Doc. No. A1CL1/1 [Parts Details]). Trace and cut to shape the fin from the 3mm (1/8”) plywood using the coping saw (see Doc. No. A1CL1/1 [Parts Details]). With fine sandpaper, round off the leading and trailing edges, and the tips of the stabiliser, elevator and fin.

Fit the nylon hinges into the elevator as shown on Doc. No. A1CL1/2 [General Arrangement]. This is done by cutting slits centrally into the leading edge of the elevator. The hinges are then pushed into the slits with balsa cement to secure them in place. Be sure not to get glue on the hinge pin arrangement, as it will make the pin stiff and hard to move.

While the hinges in the elevator are drying, glue the stabiliser onto the fuselage using balsa cement and hold it in place with pins until dry. Be sure that the stabiliser is square to the fuselage both when looking from the top and the end. When dry, glue the fin into place using epoxy glue. Be sure to offset the fin as shown in the top view on Doc. No. A1CL1/2 [General Arrangement].

Once the glue has dried at least 30 minutes, fit the hinges of the elevator into the trailing edge of the stabiliser. This is done in the same manner as that used in fitting the hinges into the elevator. The elevator should swing freely on the hinges.

Wing

The wing cord is 112mm (4-1/2”), and since standard balsa is 75mm (3”) wide, the wing has to be constructed from more than one piece of balsa. The wing span is 600mm (24”), and the standard balsa plank is 900mm (36”) long.

First cut the 600mm (24”) length from the plank. A 75mm x 300mm (3” x 12”) piece will remain, and this should be cut in half to make two 38mm x 300mm (1-1/2” x 12”) pieces. These are then double cemented to the 75mm x 600mm (3” x 24”) piece to form a 112mm x 600mm (4-1/2” x 24”) wing, making up the trailing third of the wing. It is important for the strength of the structure to be certain that the main (forward) piece of the wing runs from wing tip to wing tip in one piece. Allow to dry for at least 8 hours before proceeding.

Before carving the wing to shape, make an aerofoil template. This is shown on Doc. No. A1CL1/1 [Parts Details]. Draw or trace the shape carefully onto the 3mm (1/8”) plywood. Cut out the template halves and, as the wing shape progresses, check the contour of the wing with the templates by holding them against the top and bottom of the wing. Carve the wing, a little at a time, using a sharp knife and/or small block plane.

Complete the final shaping using sandpaper on a block.

Two recesses must be carved into the finished wing. One is for the washer counter weight in the outboard tip; the other is for the bell crank mount. Trace the outline of the counter weight on the underside of the wing and, using a razor blade or modeller’s knife, cut inside this outline. When the counter weight fits in the hole, glue it in place with epoxy. After the glue is dry (about 30 minutes), the remainder of the hole can be filled with balsa filler. When balsa filler dries, it has all the characteristics of balsa wood and can be carved, sanded, or drilled.

Use balsa filler for any imperfections in your carving and, when it is dry, sand it smooth with a block. Never use plastic wood on balsa models; it dries so hard that it cannot be sanded properly. Balsa filler is also ideal for making wing and tail fillets.

The bell crank mount is made from two squares of 3mm (1/8”) plywood epoxy glued together to form a 6mm (1/4”) mount. The recess in the bottom of the wing must accommodate both the bell crank mount and the bell crank-retaining nut. Do not cement the mount in place at this time.

The wing is now epoxy glued to the fuselage. First, slip the wing into the fuselage opening to be certain that it fits snugly; apply epoxy glue all around the joint and then set it aside to dry thoroughly. Be sure that the fuselage is in the exact midpoint of the wing. Be sure that the wing is square to the centreline of the fuselage and that the trailing edges of the wing and stabiliser are parallel.

End Plates

Draw or trace and cut to shape the wing tips from the 3mm (1/8”) plywood using the coping saw (see Doc. No. A1CL1/1 [Parts Details]). With fine sandpaper, round off all corners until nicely rounded. Drill two holes in the inboard plate to act as control-line guides. End plates serve an aesthetic as well as a functional purpose on this model. They create the illusion of wing-tip drop tanks and thus give the design the appearance of a modern fighter plane. Operationally, wing end plates prevent the passing air from spilling over the tips (tip vortex) On the average wing this tip vortex causes turbulence which, in turn, reduces the lift of the aerofoil. End plates, therefore, improve the lifting efficiency of the wing by eliminating unwanted turbulence.

Glue the end plates to the wing using epoxy glue.

Bell Crank Installation

Give special attention to the installation of the bell crank. The bell crank must be securely installed because this attachment absorbs the entire pull of the model as it speeds around the flight circle and therefore must be strong enough to support several time the weight of the model.

The bell crank assembly should be firmly mounted to the bell crank mount. Epoxy glues the bell crank mount into the recess in the wing. This should include gluing the bell crank securing nut to the bell crank mount but be careful not to get any glue on the threaded portion of the bell crank-securing bolt. This bolt will need to be undone later. A good way to stop glue from getting onto the bell crank-securing nut is to apply a light coating of petroleum jelly to the thread. The glue will not adhere to a surface coated with petroleum jelly.

Once the bell crank mount has dried for at least 30 minutes, remove the bell crank by unscrewing the bell crank securing bolt. Fill any imperfections with balsa filler and, when dry, sand smooth.

Finishing

First the plane should receive a final light sanding all over with very fine sandpaper, and then two coats of dope should be liberally brushed onto the entire model. Use a camel's-hair brush about 10mm (3/8") wide and flow the dope onto the model. Be careful not to get the dope on the elevator hinges because it will make them stiff. When the dope is thoroughly dry, sand the entire model with very fine sandpaper. Apply a third coat of dope that should be lightly sanded when it is thoroughly dry.

After the third coat of dope, the entire model (except the engine mounts) should be sheathed in model aircraft tissue paper. This is done by cutting the tissue paper roughly oversize to shape and laying is onto the surface of the aeroplane. Dope is then brushed onto the outer surface of the tissue and worked through the tissue until the tissue is thoroughly impregnated with dope. Pieces of tissue must overlap at their edges to ensue that the entire aeroplane is sheathed.

Once the entire aeroplane has been sheathed and the dope thoroughly dried, apply two more coats of dope. When this dope in thoroughly dry, sand smooth with very fine sandpaper, being careful not to sand through the tissue. If you will be painting your model, now is the time to apply the fuel proof paint in accordance with the manufacturer's directions. If you will not be painting the model apply two more coats of dope and allow to thoroughly dry.

Control Installation

The lead-out wires are cut from 0.5mm (0.02") diameter piano wire. Bend the wing-tip end of each as shown on Doc. No. A1CL1/2 [General Arrangement]. Pass the lead-out wires through the holes in the wing-tip end plate. Bend the bell crank ends of the lead-out wires 90° and pass them through their respective holes in the bell crank. Then bend the bell crank ends of the lead-out wires into a "U" around the bell crank so that they do not come out of their bell crank holes.

Fit the nylon control horn to the elevator as shown in Doc. No. A1CL1/2 [General Arrangement]. Bend the wire control rod to shape as shown on Doc. No. A1CL1/2 [General Arrangement]. If using a threaded ball link at the control horn end, there is no need to bend the control rod at that end. Fit the control rod to the bell crank through the hole nearest the bell crank securing bolt. The other end of the control rod should be passed through the hole in the control horn that is furthest away from the elevator. The holes selected for the fitting of the control rod will ensure that the elevator has the least movement in relation to movement of the bell crank.

These holes may be changed later as you get use to flying the model aeroplane.

If you are using a 2-56 threaded ball link with 2-56 threaded coupler, solder the threaded coupler onto the end of the control rod.

Refit the bell crank assembly to the plywood bell crank mount. If all has been properly prepared, the elevator should be in the neutral position when the long arm of the bell crank is parallel to the fuselage.

Wheels

The wheels are held in place using the 2.4mm (3/32") wheel collars. A washer is epoxy glued or soldered to the axles on the inboard side of the wheels to space the wheels properly away from the landing gear wire.

Make sure all wheels run freely after fitting.

Fuel Tank

Any commercial fuel tank of the wedge design can be used on this model, but the tank shown on the plans fits it perfectly. To prevent the fuel tank breather pipe from siphoning out fuel, it is a good idea to fit a short length of plastic fuel line to the breather. This fuel line is cut at 45° so that the air rushing past tends to be forced into the tank. A similar piece of fuel line should be fitted to the fuel tank fill pipe for the same reason.

The tank is held in place against the engine mount and fuselage by means of a brass strap. Screw one end of the strap to the engine mount and then draw it tightly over the fuel tank to the top of the fuselage and secure it with the other wood screw. The fuel tank must be rigidly mounted or vibration will cause foaming of the fuel that will result in erratic engine operation.

Engine Instillation

Last but not least is the engine installation. Mark off and drill the holes in the engine mount and bolt the engine in place. The engine should be aligned with the centreline of the fuselage. There is no need to offset the engine on this model as the fin has been offset to ensure that the aeroplane does not tend to fly towards the centre of the flying circle. Cut the fuel line to length and slip it onto the engine and fuel tank.

If the engine is fitted with a muffler (recommended), the muffler may incorporate a pressure bleed nipple. This is used on some model aeroplanes to pressurise the fuel tank. On this model aeroplane the fuel tank is not pressurised.

Trim

Touch up the paint here and there as needed, and add decals to suit your taste.

Balance

The model must be balanced correctly before you try powered flight. The optimum balance point is shown on Doc. No. A1CL1/2 [General Arrangement]. Balance the aeroplane at this point. If the tail drops add a lead weight to the extreme forward end of the engine mount; if the nose drops, add a lead weight to the extreme rear of the fuselage. All weights should be firmly affixed with screws and epoxy glue.

Test Flight

Your model is now ready to fly. Follow the instructions in Doc No. A4CL0/2 [Basic Flying Instructions] and you will discover the unparalleled enjoyment of model aeroplane flying.