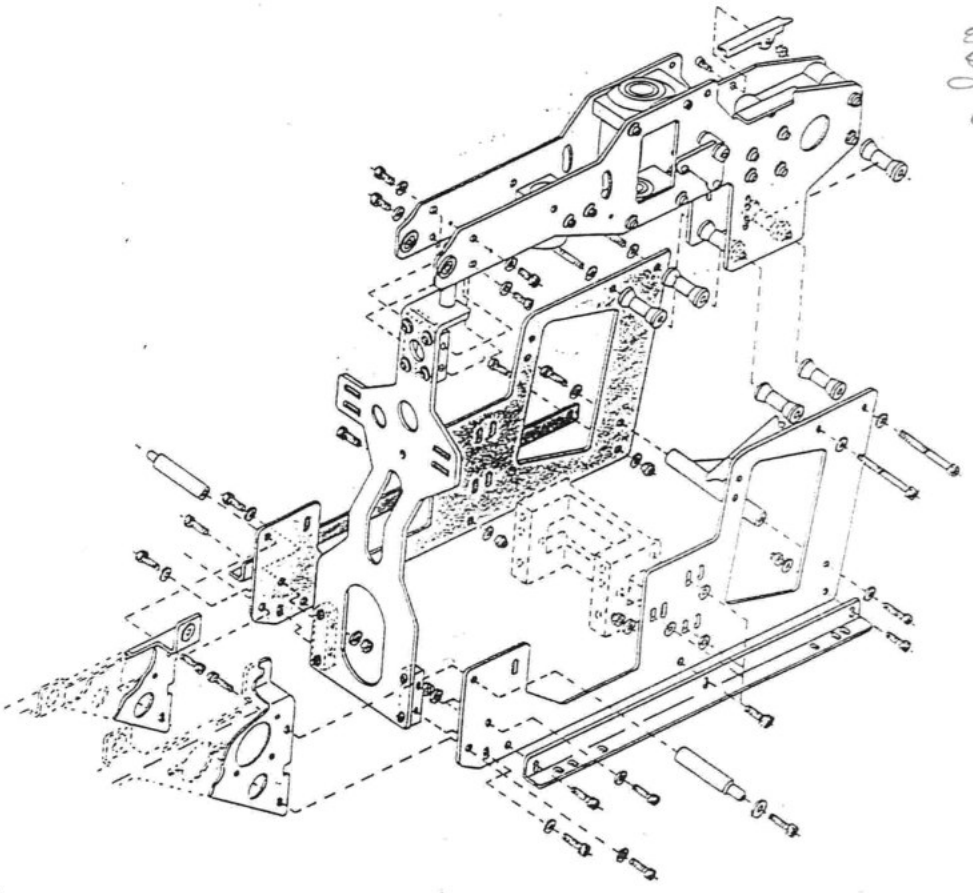
SCHOONARD Helicopters

X-CELL

Xl-Pro

Instruction Manual

Part Number: 1006



miniature aircraft usa

R/C HELICOPTER SAFETY

A radio-controlled model helicopter is a technically complex device that must be built and operated with care. It is also a fascinating and challenging part of the R/C Sport, the mastery of which is very rewarding.

A model helicopter must be built exactly in accordance with the building instructions. The kit manufacturer has spent much time and effort refining his product to make it reliable in operation and easy to build. The essentially bolt-together construction can proceed quite rapidly, giving the builder a strong sense of accomplishment that encourages too-rapid progress from one construction phase to the next, so that the completed model can be more quickly seen and enjoyed.

It is essential to recognize and guard against this tendency. Follow building instructions exactly. Use only original parts - even single screws - and consider no alterations. Vibration and stress levels are high and all fasteners and attachments must be secure for safety in operation.

Note that this is the first use of the word SAFETY in these comments. Previously the kit manufacturer's efforts to ensure RELIABLE operation were mentioned. That is ALL that he can do. Safe operation is the responsibility of the builder/flyer and starts with careful construction and continues with selection and installation of reliable radio equipment, engine, and fuel system, and the proper use of starters and other support equipment.

The need for safety is nowhere greater than at the flying field. A number of guidelines for safe flight have been developed by experienced flyers and are set down here. It is urged that they be read, understood and followed.

GUIDELINES FOR SAFE R/C HELICOPTER FLIGHT

1. Fly only at approved flying fields and obey field regulations.
2. Follow frequency control procedures. Interference can be dangerous to all.
3. Know your radio. Check all transmitter functions before each flight.
4. Be aware that rotating blades are very dangerous and can cause serious injury. Always hold the rotor head while starting the engine and do not release until at the take off point.
5. Never fly near or above spectators or other modelers.
6. If a beginner, get help trimming the model, and flight training later.
7. Don't "track" the main blades while holding the tail boom. This is a temptation to builders who cannot hover yet and is very dangerous.
8. Follow all recommended maintenance procedures for model, radio, and engine.

600309

X-CELL

WARRANTY REGISTRATION

Please print or type, filling in the information listed below and mail immediately

600309

SERIAL NUMBER

Model No:_____ Serial No:_____ Price Paid:_____

Owners Name:_____ Age:_____

Address:_____

City:_____ State:_____ Zip:_____

Purchased From:_____

Dealer's Address:_____

_____

Comments:_____

_____

WARNING

This helicopter is not a toy, but a complex flying machine that must be assembled with care by a responsible individual.

Failure to exert care in assembly, or radio or accessory installation, may result in a model incapable of safe flight or ground operation. Rotating components are an ever-present danger and source of injury to operators and spectators.

Since the manufacturer and his agents have no control over the proper assembly and operation of his products, no responsibility or liability can be assumed for their use.

X-CELL LIMITED WARRANTY

The warranty covers defects in material or workmanship or missing components to the original purchaser for 30 days from the date of purchase. Miniature Aircraft, USA will replace or repair, at our discretion, the defective or missing component. Defective components must be returned to us prior to replacement.

Any part, which has been improperly installed, abused, crash damaged or altered by unauthorized agencies is not covered. Under no circumstances will the buyer be entitled to consequential or incidental damages. The components used in this kit are made from special materials designed for special applications and design strengths. We recommend that all replacement parts be original parts manufactured by Miniature Aircraft, USA, only to ensure proper and safe operation of your model. Any part used which were manufactured by any firm other than Miniature Aircraft, USA VOIDS all warranties of this product by Miniature Aircraft, USA.

PROCEDURES

Mail all **warranty information within 15 days** of original purchase date. If service is required, send the component in question (if not missing) together with a **photocopy** of your **bill of sale** and an **accurate description of the problem and part**. Ship components fully insured and prepaid. Miniature Aircraft, USA is not responsible for any shipping damages. We will, at our discretion, notify you of any costs involved, or ship it COD. **You are required to pay all postage, shipping and insurance charges.**

MINIATURE AIRCRAFT, USA
3743 Silver Star Road
Orlando, FL 32808

Phone (407) 292-4267
FAX (407) 292-4296

INTRODUCTION

Congratulations! You have just purchased the highest quality Helicopter kit available and one which will build up in a short time into the finest flying helicopter on the market today!

There -- the conventional introduction has been taken care of!

If you just skimmed through it, that's fine. It was there just to get you up to speed anyway. Be warned, however, that is one of very few paragraphs that you dare skim through in this Construction Manual!!

We won't list all of the features of the helicopter here either. You probably read our brochure before buying the kit and it lists over forty impressive features. If you gave your copy to a friend, there is another in the kit. After you refresh your memory, give this one to another friend.

Briefly, this is a light weight, beautifully performing chopper that is ruggedly built of quality materials embodying state-of-the-art design and engineering. This Construction Manual will attempt to do justice to it. Read on.....

SYSTEM REQUIREMENTS

In addition to the kit, you will require:

1. A Helicopter Radio with 5 Servos

Typically, such a radio provides 5 or more channels to control Fore and Aft Pitch (Elevator); Roll (Aileron); Yaw (Rudder); Throttle; and Collective Pitch (changes pitch of both main blades together to vary lift). Throttle and Collective Pitch servos are controlled together by the normal throttle stick movement. This arrangement not only provides adequate servo power for all functions, but also allows important channel mixing functions to be provided by the transmitter.

In any event, it is recommended that any system used incorporate powerful, precise centering, ball bearing servos in order to realize optimum performance from this very responsive helicopter.

2. An Engine and Matching Muffler

Since the Pro is offered in a .60 (10cc) version, a wide choice of engines are available. Its light weight allows good performance with virtually any modern two-stroke engine in good condition; this characteristic, coupled with outstandingly "tight" and balanced control response, provides unequalled performance with the higher power engines.

A matching muffler is required in a configuration that directs the exhaust down and away from the engine when mounted in the helicopter position. Miniature Aircraft, USA provides a wide selection of mufflers and tuned pipes ideal for helicopter use, as well as offering several engines especially selected to provide top performance.

3. A Rate Gyro

Probably the one advance in model helicopter technology that contributes most to easy and enjoyable flight is the insertion of an "angular rate sensitive" gyroscope in the yaw (rudder) servo lead from the receiver. This device senses even minute swings of the helicopter nose (yaw) left or right and makes immediate corrective inputs to the tail rotor servo to counteract these movements. This action is not to be confused with that of an "autopilot" in that it does not keep the helicopter pointed in one direction. The amount of its corrections depends on how sharply the nose begins to swing - a small correction for a small amount, or a larger correction for a larger amount. In other words, the gyro response varies with the angular rate of change, which is why this particular type of gyro is called a "rate" gyro as distinguished from a "position" gyro.

The important effect is to make the helicopter much easier to control, and it is highly recommended that a gyro be used in the X-CELL. Miniature Aircraft, USA has offered rate gyros to modelers since their inception and currently stocks units ideal for all helicopter use.

It is essential to have your Radio and Engine on hand before beginning kit construction because they will

be needed fairly early in the building sequence. The Muffler and Gyro are not such immediate needs except that the gyro control switch box is easier to install early.

CONSTRUCTION

The Pro has been designed for easy and straight-forward assembly but, like any precision device, considerable care should be taken and work should progress in a methodical and orderly fashion.

Please read these instructions thoroughly, prepare your work place, and get all required tools together before you begin.

THE KIT PACKAGE

The kit includes detailed drawings showing all parts - with numbers - in proper relation to each other in easy to understand subassemblies. Also included is a detailed pictorial fastener list, radio and servo installation, and set-up data such as exact push rod lengths where possible, and a metric scale for your convenience. Metric hardware is used because its design and quality are superior for use in precise mechanisms.

By taking out just the major parts and the bag of small parts called for in any assembly step, confusion between similar parts and fasteners can be minimized.

Also in the box will be a small bag of spare parts such as nuts and bolts. A package containing Allen wrenches and certain other special tools needed for construction is also included.

TOOLS REQUIRED

In addition to the tools listed below, it is quite important to have a good place to work. An actual workbench is not needed because no metalworking (filing, etc) is required and just the blades and fiberglass canopy require material removal and sanding operation. Your work table should, however, be protected from marring by the various metal parts used.

Screwdrivers - both slotted and cross-recess (Phillips Head) #00, #1
Long-Nosed Pliers
Tweezers
Hand Drill with appropriate bits
Dremel Power Tool or equivalent
Small Fine File
5.5mm Open End Wrench (can be 7/32")
7mm Open End Wrench (can be 9/32")
Allen Wrenches (supplied in kit)
Appropriate Socket Wrench for your engine shaft nut
Vinyl Two-Sided Servo Tape 1/8" (#3869)
Glowplug Wrench (Part #4648)
Scissors
Slow Zap (#4917)
Thin Cyanoacrylate Glue (#4881)
Loctite (MA/USA) thread lock liquid (supplied in kit)
(**NOTE:** Use only the material supplied or its EXACT equivalent)
Masking tape, Paint for finishing Canopy, 80 and 220 Grit Sandpaper
Heat Gun (Monokote type)
Grease, Teflon Filled (Order #4709 - 2 oz tube, or #4707 - 1 oz syringe)
Tri-Flow Teflon Oil (Part #4801)
J.B. Weld Epoxy (#4853)

In addition, the following will make assembly easier and prove useful later, in your model toolbox:

Ball Link Application Tool (part #0529)

5.0mm Nut Driver (#4669)
5.5mm Nut Driver (Socket on a Handle) (#4670)
7mm Nut Driver (#4671)
Fan Drive Collet O.S. SX (#0262)
Fan Drive Collet 7mm Enya 60 (#0265)
Fly-Bar Alignment Kit (#0510)
Universal Swashplate Lock (#0512)
1.5mm Allen Wrench on a Handle (#4651)
2.0mm Allen Wrench on a Handle (#4653)
2.5mm Allen Wrench on a Handle (#4655)
3mm Allen Wrench on a Handle (#4657)
Ball Link Pliers (Part #0545)
Pitch Gauge (Part #0526)
Flybar Lock (Part #0505)
Tail Rotor Blade Balancer (Part #3750)

These tools can be obtained from your local hobby shop, or ordered directly from Miniature Aircraft, USA.

ASSEMBLY INSTRUCTIONS

The instructions to follow will build up subassemblies and incorporate them in the helicopter in a logical sequence. The subassemblies will be clearly recognizable on the main drawing as will the parts and fasteners used. Take a few minutes to carefully study the entire drawings before beginning assembly. Note that the drawings include a series of "exploded" views which show the various subassemblies with the individual parts shown unassembled but in relative positions which make obvious the manner in which the parts fit together to create the subassembly.

Each assembly step will begin with an exact list of parts required including locations in the kit box where appropriate. There is essentially no difference in assembly operations. It will be helpful to have a small dish, or box available in which to place the small parts, bolts and nuts for each step for easy access. Any special tools required will be called out in the text.

NOTE: Beginning the assembly sequence with the Rotor Head rather the basic Main Frame Structure may seem unusual but allows the use of the engine start/clutch shaft as a very effective alignment tool to facilitate Rotor Head assembly before the shaft itself is assembled.

ASSEMBLY SEQUENCE

I. ROTOR HEAD ASSEMBLY

STEP
1. Install The Pivot Block and the Head Button into the Head Block
2. Final Assembly of the Fly-Bar Yoke and Guide Pins
3. Building and Installing the Bell Mixers
4. Assemble and Install the Main Blade Mounts
5. Add the Fly-Bar, Control Arms and Paddles
6. Assembly of Flybar Paddles

II. SERVO SIDE FRAME ASSEMBLY

STEP
1. Mounting Servo's
2. Assembling Servo Side Frames Together
3. Installing Push-Pull Bellcranks
4. Install Control Balls on Push-Pull Bellcranks
5. Assemble Radio-Battery Support Frames
6. Mounting Corner Blocks and Canopy Stand-off on Aluminum Vertical Frame Plate
7. Mounting the Roll Servo

III. BUILDING TOP MAIN FRAME SECTIONS

STEP 1. Assemble Aileron (Roll) Bellcranks to Main Frames
2. Mounting Tailrotor Guides, Rubber Grommet Isolators, and the Gyro Mounting Plates
3. Assemble Clutch Shaft Double Bearing Block, and Front Tail Drive Transmission
4. Bolting the Top Main Frame Together

IV. BUILDING LOWER MAIN FRAME SECTIONS

STEP 1. Assemble Lower Main Frame Section and Attaching Vertical Aluminum Frame Plate
2. Assembly of the Top Main Frame Section to the Lower Main Frame Section
3. Attaching the Servo Side Frame Assembly

V. ASSEMBLY OF THE MAIN SHAFT AND AUTOROTATION UNITS

STEP 1. Assemble Elevator Bellcrank
2. Installing the Mainshaft, Autorotation Unit with Maingear, and The Slipper Autorotation Unit.
3. Assemble the Slipper Autorotation Unit and Adjustment of the Main Shaft Assembly

VI. COLLECTIVE AND ELEVATOR PUSH-PULL ASSEMBLY

STEP 1. Installing the Collective System and Elevator Pivot Studs
2. Install Collective Arm Doubler and Collective System
3. Assembly of Elevator Push-Pull

VII. MAIN SHAFT ASSEMBLY

STEP 1. Assembling Swashplate
2. Installing the Swashplate Antirotation Bracket
3. Assembly of Wash-Out Unit

VIII. INSTALLING ENGINE AND FAN SHROUD ASSEMBLIES

STEP 1. Mount Flywheel and Clutch Assembly
2. Install and Align Engine in Frames
3. Mounting Male Universal(Uni-Lock) onto Starter Extension
4. Installing the Fan Shroud Assembly

IX. INSTALLATION OF LANDING GEAR ASSEMBLY

STEP 1. Assemble Landing Gear and Install

X. ASSEMBLE THE TAIL ROTOR TRANSMISSION

STEP 1. Assemble Tailrotor Hub and Blade Holders
2. Mount and Balance Tail Rotor Blades
3. Assemble Pitch Slider and Bellcrank
4. Assemble Gear Box
5. Install Assembled Tail Rotor Hub

XI. BUILDING THE TAILBOOM

STEP 1. Installing Tube Drive
2. Installing the Tail Rotor Pushrod Guides and Fin Mounts

XII. **INSTALLING FUEL TANK AND EXHAUST SYSTEM**

STEP 1. Fitting the Fuel Tank and Exhaust System

XIII. **INSTALLATION OF RADIO EQUIPMENT**

STEP 1. Installation of Servo's
2. Install the Switch for the Receiver, Gyro, Radio Receiver and the Antenna
3. Mounting the Battery

XIV. **ASSEMBLING AND INSTALLING PUSHRODS**

STEP 1. Assemble and Install T/R and Collective Push-Pull Rods and connect to Servo's
2. Installing Collective Arm Rods
3. Installing Throttle Pushrod
4. Install Elevator Push-Pull and Elevator Push Rods
5. Install Right and Left Cyclic Pushrods
6. Install Lower Swashplate Control Rods
7. Installing Rotor Head and Fly-Bar Control Rods
8. Installing Hiller Control Rods
9. Installing Special Control Rods on the Head

XV. **CANOPY PREPARATION**

STEP 1. Mounting the Clear Lexan Window
2. Mounting Canopy
3. Installation of Thumb Screw Plastic Caps

XVI. **BUILDING THE ROTOR BLADES**

STEP 1. Assembling Blade Mounts
2. Adding Lead Strips
3. Initial Balancing
4. Cover Blades
5. Final Balance of Blades and Rotorhead
6. Adjustment of Static Tracking

XVII. **FINAL MECHANICAL AND ELECTRICAL SET-UP**

STEP 1. Collective Servo and Collective Arm
2. Final Swashplate and Fly-Bar Alignment
3. Adjusting Pitch Curves
4. Adjusting Swashplate Throw
5. Adjusting Rudder
6. Gyro
7. Elevator and Aileron Dual Rates and ATV

XVIII. **FINAL ASSEMBLY INSPECTION**

XIX. **NECESSARY FLIGHT ITEMS**

XX. **STARTING AND STOPPING ENGINE**

XXI. **FIRST FLIGHT ADJUSTMENTS**

I. ROTOR HEAD ASSEMBLY

NOTE: At the builders discretion the bearings and shaft in this section may be glued together using locktite (red, green, or blue). If you choose to do this the disassemble process will become very difficult and will require the application of heat to break down the glue.

Step 1. Install the Pivot Block and the Head Button into the Head Block

Parts Required:

2	#0033	M3x5 Phillips Machine Screws	Bag 1B
1	#0289	Head Block	Bag 1A
1	#0294	Long Pivot Block	Bag 1B
2	#0301	Pivot Ball Bearings	Bag 1B
1	#0509	Large Head Button	Bag 1B
2	#0563-1	Brass Inserts	Bag 1B
2	#0563-2	M3x8 Socket Set Screws	Bag 1B

Refer to Drawings # 1.

A. Clean the I.D. of the pivot ball bearings #0301 and the long pivot block #0294 using a paper towel and some thinner. At builders discretion apply a very small amount of locktite to the shaft on both sides of the pivot block. Slide the bearings all the way on the block, one on each side. (If necessary, tap into place, applying force only to the inner race.)

B. Identify the two small holes recessed at the end of the middle bore in the #0289 head block and squarely thread an M3x5 Phillips head screw #0033 into one hole until it seats. Do not over-tighten. Slide the pivot block unit into the middle bore from the other end until it seats against the screw head previously installed. Thread the other M3x5 phillips screw into the remaining hole until it seats and traps the pivot block assembly. Neither screw should be so tight as to bind the bearings. Instead, they should be adjusted equally so that neither end play nor binding exist.

C. Using either a X-acto knife or 220 grit sandpaper, rough up the top of the head block around the center hole and the bottom portion of the head button #0509 where the two parts will make contact. Apply a small portion of Slow Zap to the head button only! Do not allow any Zap to run down into the head block. Press the head button into the block #0289 and seat fully. Use Kicker to dry the Zap on the outside of the block to keep the glue from running down the block while drying if needed.

D. **Installing Static Tracking Screws**

Purpose:

To allow adjustable static tracking of the rotor head due to slight variations in blade height at the tips by eliminating any looseness about the mainshaft due to wear or stretching of the base of the head block.

Special Tools Required:

1 Small Hammer

Examine the head block #0289 closely. On each side (at the base) just above where each #0297 pin is installed, you will notice a hole molded in the plastic.

Select an M3 bolt from the spare parts and screw it 3/4 of a turn into the knurled end of one of the brass inserts (#0563-1). Hold this straight with respect to the hole and use light tapping pressure on the bolt head (with a small hammer) to start the insert into the hole.

When you are satisfied that the insert has started into the hole straight, remove the M3 bolt and use the hammer to set it flush with the head. Due to it's slotted construction and knurled edge, the brass insert will "set" itself firmly into the plastic. No Cyano is required. Repeat the process on the other side.

Again, using an M3 socket-head bolt from your spares, it is now necessary to test the threads. Screw the bolt into the insert slowly. It will have some resistance and possibly squeak a little. This is fine since this process will spread the insert deeper into the sides of the hole. Remove the bolt and repeat on the other insert.

Start each set (#0563-2)screw and screw in until it is flush with the surface of the rotor head. Final adjustment will come after the main rotor blades have been mounted.

Step 2. Final Assembly of the Flybar Yoke and Guide Pins

Parts Required:

4	#0063	M3x10 Socket Head Bolt	Bag 1C
2	#0115	M3x10.5 Threaded Ball	Bag 1C
2	#0292	Flybar Yoke Halves	Bag 1C
2	#0296	Pivot Block Spacers	Bag 1C
2	#0297	M2.5x24 Guide Pins	Bag 1C
2	#0298	Delrin Bearing Cups	Bag 1C
2	#0299	Flybar Bearings (M4x10)	Bag 1C
2	#0339	Delta III Plates	Bag 1C

Refer to Drawings # 1.

A. Rotate the pivot block until the cross hole is squarely visible through the side slots in the head block (it may be held in this position using the clutch shaft of the clutch assembly #0267). Slide one #0296 plastic spacer onto each end of the exposed shafts from the pivot block #0294. Holding the pivot block cross hole level within the head block and press one #0292 flybar yoke half (rounded side outward) fully onto each end of the pivot block. Align each flybar yoke half with the "tool" leveling the pivot block. This step is important but not critical since the through hole in the pivot block is only a "clearance hole" for the flybar to pass through.

B. Examine each #0298 Delrin bearing cup. Note that one side is made to accept an #0299 (M4x10) bearing with a snap fit. Insert one #0299 bearing into each bearing cup, making sure that it is fully seated. Select both #0339 delta offset plates. The O.D. of each #0298 bearing cup is designed to snap into the delta offset plate. Install one into each plate.

For your convenience, temporarily apply a small piece of tape on each side of the rotor head block and designate one side as the left side and one as the right side. Examine each delta offset plate carefully. You will see that each is symmetrical with the exception of a protruding end with an M3 threaded hole. Holding the rotor head block with the left side facing you, position one delta offset plate up against one end of each flybar yoke half (aligning each un-threaded hole in the plate with each flybar yoke half hole) with the M3 threaded hole offset to your right. Install two M3x10 socket head bolts with a small amount of slow cyano through each delta offset plate and into each flybar yoke half. Be sure that the bearing faces outward. Rotate the head block 180° and repeat the process. This pivot block/delta plate assembly should now pivot freely and the through hole in the pivot block should be in alignment with each M4x10 bearing.

Apply a small amount of Loctite to each #0115 threaded ball and install them from the outside into each delta offset plate. Note that each will slightly scuff against the head of the nearest M3x10 socket head bolt during installation. This will not cause any problem. Be sure each #0115 ball is fully tightened.

C. Drive the two #0297 guide pins into the bottom holes in the head block until they seat solidly. (They will project about 16.0mm when seated.) **NOTE:** The lower 8mm of the pins #0297 may be roughened with 80 grit sandpaper and press in place with epoxy or slow cyano.

Step 3. Building and Installing the Bell Mixers

Parts Required:

2	#0093 M3x18 Special Bolt	Bag 1D
4	#0107 M3x6 Steel Threaded Ball	Bag 1D
2	#0317 Main Blade Mount	Bag 1A
2	#0562-1 M3x5 Washer	Bag 1D
2	#106-01 Machined Aluminum Bell Mixer	Bag 1D
4	#106-02 M3x7 Flanged Bearings	Bag 1D

Refer to Drawings # 1.

A. Clean the entire bell mixer #106-01 in thinner to remove any oil. Clean the O.D. of the M3x7 flanged bearings #106-02. At the builders discretion use red or green loctite to install the bearings into each mixer. **NOTE:** If more pressure is required than thumb pressure to install the bearing, find a small socket that fits the flanged portion of the bearing and gently press the bearing into place.

B. Install two M3x6 steel threaded balls #0107 into each bell mixer with Loctite. View drawing to ensure that they go in from the correct side. Several different ratios for different styles of flying are available. The following is a description of each which will give you a idea which ratio is right for your type of flying.

<u>NOTE:</u> Section 1 and 2 refer to specific bell mixer mounting positions refer to diagram below.

1) The 1:1.3 and 1:1.6 are the two ratios that we recommend for "hot dog" type flying. 1.3:1 will give a useable collective range of 25 degrees and 1.6:1 will give a usable collective range of 27 degrees. The 1.6:1 will have a little more collective range, more direct cyclic input to the blades and less flybar authority. Either one of these ratios combined with our Pro-II Paddles #0561-5 (at 35.0 grams or less) will give very stable fast forward flight while also giving an abundance of cyclic power for tumbles, tight loops and consecutive rolls. Either of these two ratio's will produce very fast cyclic power and should be approached cautiously.

2) The 1:1, 1.3:1 and the 1.6:1 will work as well for competition type flying when you need a stable hovering machine combined with smooth stable cyclic controls for doing graceful aerobatics. The 1:1 ratio will provide 22 degrees of useable collective range, 1.3:1 ratio - 20 degrees and the 1.6:1 - 17 degrees.

C. Examine the #0317 blade mounts. Two holes are provided on each pitch arm for the installation of the bell mixers. For the purpose of this particular model, you will only be using the hole nearest the main body of the blade mount. Upon further examination, you will find a small raised area surrounding each hole. Since the outer hole is not to be used, it is advised that you remove the small raised area from that hole. A sharp knife will do this

easily. This will provide suitable bearing clearance when the bell mixer is finally installed in the other hole.
Select one M3x18 Phillips Head bolt #0093 and screw about half way through the blade mounts pitch arm and make sure that it threads in straight. Take the bolt out and push the bolt through the bell mixer. Place one M3x5 washer #0562-1 on the bolt then restart the bolt in the main blade mount and screw it all the way in until the bearings just start to drag then unscrew the bolt slightly. Once adjusted apply a liberal amount of slow Zap on the exposed threads of the bolt protruding out on the inside of the blade mounts pitch arm.

Step 4. Assemble and Install the Main Blade Mounts

Parts Required:

2	#0021	M4 Locknuts	Bag 1E
2	#0082	M4X45 Socket Head Bolt	Bag 1E
1	#0315	Main Blade Axle	Bag 1E
1	#0316	10mm Fuel Tubing	Bag 1E
4	#0319	Ball Bearings	Bag 1E
2	#0321	Thrust Bearings	Bag 1E
2	#0323	Dampener Rubber O-Rings	Bag 1E
2	#0327	Bearing Retainer Washer	Bag 1E
2	#0329	Thin Shim Washer	Bag 1E
2	#0325	Thrust Bearing Spacer	Bag 1E
2	#0085	M5x16 Socket Head Bolt	Bag 1E

Refer to Drawings # 1.

NOTE: Prior to beginning this section, be sure to degrease the threads in the #0315 blade axle and bolts #0085 with alcohol or thinner.

A. Using a pair of needle nose pliers, spread the 10mm piece of fuel tubing #0316 over the #0315 blade axle. Center the fuel tubing on the blade axle and glue in place with slow cyano. NOTE: The fuel tubing will be providing the lifting point for the model instead of the #0323 O-rings doing this job. This will allow the O-rings to provide dampening for the model which is what they are designed to do.

B. Select both #0317 main blade mounts from Step #2. Also select four #0319 ball bearings, one #0321 thrust bearing, one #0325 thrust bearing spacer, one #0327 retainer washer, and one #0085 M5x16 socket head bolt from the parts bag. Press a ball bearing into a blade mount cavity on the control arm end. Seat it fully. Press the second ball bearing into the mount from the fork end. Seat it squarely and fully by using a socket or pipe of suitable diameter (the same O.D. as the bearing) to avoid any pressure on the inner race. Check alignment by sliding the #0315 main blade axle through this bearing, through the mount, and through the previously installed bearing. Remove the axle. Repeat this entire process with the second blade mount.

C. Carefully slide a #0323 dampener O-ring about 30mm onto the #0315 main blade axle, taking care not to damage it on the sharp edge of the axle. Insert the long end of the axle into the top hole of the head block until the O-ring seats in its annular cavity. Slide the other O-ring on the opposite end of the shaft until it seats in its cavity.

D. Select the two #0329 shim washers (thin ones) and slide one on each end of the blade axle. Slide a blade mount on one end of the axle. Refer to drawing #_1_ for proper orientation.

E. Lay the #0321 thrust bearing on a clean surface and separate the two races and the ball ring. Note that one race has a larger inside hole diameter than the other. This point is most important. Determine the larger-holed race by slipping each race onto the end of the axle and choose the looser one. Lay the larger race down, ball groove-up, and place the ball ring on it. Apply a small amount of grease and place the other race on the ball ring (groove down). Set aside until you reach Step G.

F. Slide the #0325 thrust bearing spacer into the fork end of a blade mount up against the ball bearing.

G. Place a #0327 bearing retainer washer on the M5x16 socket head bolt and insert the screw down into the thrust bearing from the top. Apply a small amount of Loctite on the threads inside the main axle. Invert the bolt and thrust bearing assembly and, using one of the Allen wrenches in the kit, thread it into the blade axle through the fork end of the assembled blade mount. Tighten most of the way, and slide the blade mount against this stack to square it up. (The thrust bearing should engage the shouldered part of the axle with the small I.D. race nearest the head of the M5x16 bolt).

H. Repeat steps E, F, and G to install the other main blade mount. Using the two Allen wrenches in the kit, tighten the whole axle assembly firmly. (**IMPORTANT:** DO NOT OVER-TIGHTEN or axle damage may result.) Be sure each blade mount control arm is oriented to the head block as shown in view #1. This is to say that with the right hand rotation of this model, each blade will be commanded by the control arm at its leading edge.

I. Temporarily install the two M4x45 socket head bolts #0082 and two M4 locknuts #0021 into the blade holders.

Step 5. Add the Flybar, Control arms and Paddles

Parts Required:

1	#0566-1 Flybar(Inside Tailboom)	Bag 11A
1	#0019 M3 Locknut	1F
2	#0053 M3x5 Set Screws	1F
1	#0091 M3x16(12.9) Head Bolt	1F
2	#0305 Control Arm Spacer	1F
2	#0307 Flybar Control Arm	1F

Refer to Drawings # 1.

A. Insert the flybar #0566-1 into the bearings provided in the #0339 delta offset plates. Follow with one #0305 spacer and one #0307 control arm on each side. Slide each up to the delta offset plates and then center the flybar. Apply loctite and very lightly tighten the M3x5 socket set screw in each control arm until it just touches the flybar. Shift the flybar until there is no side play between the control arms and the flybar is balanced. Now sight from one side at both control arms, align each level with the other. It is helpful to use a small pair of straight edges on each control arm to insure that they are each level to the other. Securely tighten each socket set screw in each control arm. **NOTE:** Available through Miniature Aircraft USA is a special Fly-Bar Alignment Kit. Order #0510.

Step 6. Assembly of Flybar Paddles

4	#0051 M3x3 Set Screws	1G
2	#0561-6 Flybar Paddles Main Section	1A
2	#0561-7 Flybar Paddle End Caps	1A
2	#0561-8 Flybar Paddle Plastic Inserts	1A
2	#0561-9 Flybar Paddle Aluminum Safety Locks	1G
2	#0561-10 Flybar Paddle Lead Weight Thick, 44mm (5.8 grams)	1G
2	#0561-11 Flybar Paddle Lead Weight Thick, 65mm (8.6 grams)	1G
2	#0561-12 Flybar Paddle Lead Weight Thin, 65mm (5.7 grams)	1G

Refer to Drawings # 1.

A. NOTE: Before assembling the paddles it will be necessary to choose the over-all paddle weight desired by the number of lead strips used to achieve a desired flying characteristics.

The following characteristic may be expected with the installation of the lead strips:

- With no lead (total weight approximately 24.0 grams) - Crisp control with fast cyclic authority.
- With single strip of large lead mounted in insert (total weight approximately 32.0 grams) - Crisp control will remain with increased stability.
- With two strips of large lead , one mounted in the insert and the other mounted on the leading edge of the insert. (total weight approximately 40.0 grams) - Excellent hovering control with increased forward flight stability. Enhancing smooth and precise FAI type aerobatics.
- With three lead strips (total weight approximately 45.0 grams) - Extreme hovering stability. Slow and precise aerobatic maneuvers.

: Assemble both paddles simultaneously.

B. Remove all the sections of lead #0561-10, 0561-11, 0561-12 from section 1F. Roll the lead under a sanding block using 80 grit sandpaper until they are flat and thoroughly roughened. Select the shortest piece of lead #0561-10 (44mm) and press it completely into the slot in the plastic insert #0561-8, thin cyano in place.
Using 80 grit sand paper roughen the entire surfaces of the plastic inner insert 0561-8. Slow cyano glue the desired amount of lead #0561-11 and #0561-12 onto the leading edge of the plastic insert. If both pieces of the lead are used glue the thick section of lead #0561-11 on first. Carefully line up the lead pieces with the plastic insert and allow to dry. Slightly shape sand the leading edge of lead and any excess glue until the assembled plastic paddle insert will slide inside the paddle main section, #0561-6.

C. With 80 grit roughen up the internal surfaces (as best you can) of the paddle main section #0561-6 and the paddle end cap #0561-7. Slide the assembled insert #0561-8 into the main paddle section until the hole in the insert and the paddle for the aluminum safety lock aligns. If this does not align, sand the lead until alignment is achieved. Re-install the plastic insert. Align the un-threaded hole in the aluminum safety lock #0561-9 in-line with the Fly-Bar insertion hole in the plastic paddle. Press and center the safety lock into the paddle.
Wick thin zap around the protruding end of the plastic inner sleeve #0561-8. Wipe away any excess glue.

NOTE: If a gram scale is available weigh both paddles including the end caps #0561-7, to determine if they are matching in weight. To correct, drill small holes in the end of the plastic insert or add weight to the inside of the end caps. (Glue the end caps in place, only if a gram scale was used. If a gram scale is not available, proceed with the next step).

D. From each end of the flybar measure in 37mm and place a mark (masking tape works very well). Thread each flybar paddle up to the marks. Study drawings for correct paddle orientation.
NOTE: If a gram scale is not available, the flybar system will need to be checked for balance. Temporarily snap the end caps in place. Un-snap any ball links connected to the flybar system and check the flybar for a level balance. If incorrect alter paddles as described in section ("D-NOTE"). After all corrections above have been made the end caps may be glued in place. Final balance of completed paddle may be achieved by using a small piece of black tape on the paddles leading edge.

E. Temporarily thread two #0051 M3x3 set screws into each aluminum safety lock. The set screws will be securely tightened after the flybar alignment process has been completed in **Section XXII Step 2.**

F. Temporarily install the M3x16 #0091 (12.9) Phillips head retainer bolt and the M3 locknut until time to mount the rotor head.

II. SERVO SIDE FRAME ASSEMBLY

Step 1. **Mounting Servos**

Parts required:

2	#106-10	Servo Side Frame	Bag 2A
10	#106-32	1/8" ABS Block	2B
10	#106-33	Phillips Self Tapping Flat Head Screws	2B
20		Servo Mounting Screws (Supplied with radio)	
4		Servos (5, if mixture control is to be used. The 6th or roll servo will come later in Section III.)	

Special Tools Required:
Dremel tool or hand drill with drum sander.
#56 (.046) Drill Bit
#37 (.104) Drill Bit
#48 (.076) Drill Bit

Refer to Drawings # 2.

A. Select one of the servo side frames #106-10 then study drawings to aid in installing the servos in the "left" side servo side frame. Mount the servo into the side frame using 1/8th inch ABS blocks #106-32 and the self taping screws supplied with your radio. Before final tightening of screws, ensure that the servos are centered in the cutouts and that the ABS blocks are square to the servo. Use Polyzap to tack glue the ABS blocks to the servo side frames and then carefully remove servos.

B. Repeat this process for the servo on the right hand side of the servo side frame. Be careful that you put the servo in the right servo side frame in from the correct side.

C. Drill a hole in the center of the ABS blocks and through the servo side frame using a #56 (.046) drill bit. NOTE: The next two steps will be easier if a drill press with a travel limiter is used. Drill a hole through the servo side frame ONLY with a #48 (.076) drill bit. Do not go through the ABS blocks. This drill bit size is to allow easy passage of the small black flat head self tapping Phillips screws #106-33. Next use a #37 (.104) drill bit to countersink the head of the screws. Do not go to far! NOTE: On the last two steps press

down on the parts as the drill bit has a tendency to pull the part up the bit.

D. After studying the drawings to determine which way each servo is turned in it's respective cutout in the servo side frames, use a dremel tool or a hand drill and a drum sander to relieve the end of the servo cutout as to allow easier passage of the servo wire once the tray is assembled. Do this only on the side frame opposite the one with the 1/8" blocks that retain the servo. **NOTE:** Wear eye protection and clean parts thoroughly as graphite is extremely abrasive!

Step 2. **Assembling Servo Side Frames Together**

Parts Required:

2 #0009	M3 Small Washers	2C
2 #0075	M3x25 Socket Head Bolts	2C
2 #106-20	Un-threaded Frame Spacers	2C
2 #106-28	Bellcrank Standoff with M3x16 Set Screws	2C

Refer to Drawings # 2.

A. Assemble the servo side frames #106-10 together as follows using two push-pull stand-offs #106-28, two unthreaded gold frame spacers #106-20, two M3x25 socket head bolts #0075, and two M3 washers, small #0009.
(**NOTE:** The 1/8" ABS blocks must be on the inside of each servo side frame.) Slide one #0009 washer on each #0075 bolt. Insert each bolt and washer into their respective hole locations from the outside of the right servo frame. Slide one #106-20 frame spacer from the inside of the right frame onto each bolt. Lay the left servo frame over each protruding bolt #0075. The frame spacers will be in between each side frame. On the outside of the left servo side frame screw the #106-28 bellcrank stand-offs onto the remaining threads on the #0075 bolts. Do not fully tighten at this time.

Step 3. **Installing Push-Pull Bellcranks**

Parts Required:

2 #0009	M3 Washers	2D
2 #0019	3mm Hex Locknuts	2D
2 #0553-2	Flanged Bearings	2D
2 #106-26	Push-Pull Bellcranks (Gold Anodized) w/bearing #0553-2	2D
2 #106-27	Aluminum Spacer Rings	2D

Refer to Drawings # 2.

A. Install tailrotor and collective push-pull bellcranks #106-26 onto bellcrank standoffs #106-28 with the flanged portion of the bearing to the inside. Lay the Aluminum Spacer Rings #106-27 on a flat surface and press the special flanged bearing #0553-2 into the bearing spacer rings with your thumb. If more pressure is required use a small socket that will only put pressure on the outer race of the bearing. Slide the rings with bearings into the bellcrank standoffs #106-28, with the bearing to the outside. Place a M3 small washer #0009 on the set screw, then start a M3 locknut #0019. **NOTE:** Run the M3 locknut up just till everything seats. Do not over tighten. Adjust locknuts so that the bellcranks are nice and free. A bead of epoxy may be applied to the bearing spacer where it contacts the bellcrank.

Step 4. **Install Control Balls on Push-Pull Bellcranks**

Parts Required:

6 #0015	2mm Hex Nuts	2E
1 #0044	M2x12 "8.8" Slotted Machine Screw	2E
5 #0103	M2x5 Steel Threaded Balls	2E
2 #0361	M2 Steel Balls	2E

Refer to Drawings # 2.

A. Install five M2x5 #0103 steel threaded balls into push-pull bellcranks using five 2mm hex nuts #0015 and blue Loctite. Study the drawing to determine correct location of the steel threaded balls. Note that the collective push-pull bellcrank has two pushrods going to the collective arm #106-84. Install 2mm steel balls #0361 in this order: slide one steel ball onto a M2x12 8.8 slotted machine screw #0044, then push the screw and ball through the bellcrank. Place another steel ball on the screw followed by a 2mm hex nut #0015 with blue Loctite. Be careful not to over-tighten the M2x12 screw.

Step 5. **Assemble Radio-Battery Support Frames**

Parts Required:

1 #106-12	Radio-Battery Support Frame (Right)	Bag 2A
1 #106-14	Radio-Battery Support Frame (Left)	2A
1 #106-16	Graphite Battery Tray	2A
4 #0065	M3x12 Socket Head Bolts	2F
4 #0003	Flat Washers 3mm (Large)	2F
4 #0009	Flat Washer 3mm (Small)	2F
4 #0019	Hex Locknut 3mm	2F
4 #0061	M3x8 Socket Head Bolts	2F
2 #106-18	"Threaded" Spacers	2F
4 #106-22	Rubber Grommet Isolators	2F
4 #106-24	Dampening Sleeves	2F

Refer to Drawings # 2A.

A. Install the four rubber grommets #106-22 into the radio-battery support frames #106-12 and #106-14. Squeeze grommets together and push in as far as possible. Use a small straight screwdriver and work around the grommets, pushing one side all the way through. Center the four dampening sleeves #106-24 in the grommets.

B. Bolt the radio-battery support frames together using the graphite battery tray #106-16, four M3x8 socket head bolts #0061, four 3mm small washers #0009, and four 3mm locknuts #0019. Do not fully tighten at this time. **NOTE:** The tray has multiple positions should you need it for correcting the C.G. In most cases it will be as far rearward as possible.

Slide the servo side frame assembly between the radio-battery support frames and align with grommets. Squeeze the threaded spacers #106-18 between the servo side frames and align with the holes in between the rubber grommets. Using blue Loctite install four M3x12 socket head bolts #0065 with 3mm large washer #0003. Remove push-pull standoffs #106-28, apply blue Loctite and tighten. Finish tightening socket head bolts in graphite battery tray.

Step 6. **Mounting Corner Blocks and Canopy Standoff on Aluminum Vertical Frame Plate**

Parts Required:

1	#106-70	Vertical Aluminum Frame Plate	Bag 2A
4	#106-72	Frame Plate Corner Blocks	2G
1	#106-62	Upper Canopy Standoff	2G
9	#0063	M3x10 Socket Head Bolts	2G

Refer to Drawing # 2B.

A. After examining drawings, bolt all four vertical frame plate corner blocks #106-72 to the vertical frame plate #106-70 with #0063 M3x10 socket bolts. Use blue Loctite.

B. Bolt upper canopy standoff #106-62 to the vertical frame plate using one M3x10 socket head bolt #0063. **NOTE:** This is the shorter standoff which is only threaded at one end.

Step 7. **Mounting The Roll Servo**

Parts Required:

1	Servo From Your Radio System	
1	Vertical Aluminum Frame Plate (Assembly from Step 4.)	
2	#0353 Roll Servo Pivots "Female"	Bag 2I
2	#0351 Roll Servo Pivots "Male"	2I
2	#0508-1 Custom Tilt Bearings	2I
2	#0560-1 Roll Servo Spacers	2I
4	#0029 M2.2x13 Phillips Self Tapping Screws	2I
4	#0560-8 2.5mm Flat Washers	2I

Refer to Drawing # 2B.

A. Mount the female roll servo pivot #0353 to the roll servo using the hardware provided with your radio. Drill the four holes with a #56 or a .046 drill bit. Drill two holes in each of the male pivots #0351. The holes should be centered and 10 millimeters apart. Into each bearing cavity in the roll servo pivots (female) #0353, press one #0508-1 custom tilt bearing. Next press the #0351 roll servo pivot (male) into the center of the #0508-1 bearings.

B. After examining photos, mount servo to the vertical frame plate using four M2.2x13 Phillips screws #0029, four M2.5 washers #0560-8 and two roll servo spacers #0560-1. Position the servo so that the offset output shaft is centered within the frames and the bulk of the servo is to the right side of the model. Be sure that if a center line was drawn from the top of the vertical frame plate to the bottom, the output shaft would be in the center. Tighten the servo and run a small bead of thin Zap around the spacer blocks to ensure that they cannot move.

III. BUILDING TOP AND BOTTOM MAIN FRAME SECTIONS

Step 1. **Assemble Aileron(Roll) Bellcranks to Main Frames**

Parts Required:

2	#106-80 Top Main Frame Plates	Bag 3A
2	#0019 Hex Locknuts 3mm	3B
2	#0051 M3x3 Socket Set Screws	3B
2	#0105 M3x4.5 Threaded Balls	3B
2	#0107 M3x6 Threaded Balls	3B
4	#0159 Ballbearings M3x7	3B
2	#0167 Aileron Bellcranks	3B
2	#0169 Aileron Bellcrank Pivot Studs	3B
2	#106-25 Aileron Bellcrank Retainer Collars(Gold)	3B

Refer to Drawing # 3.

A. Build a left and a right top main frame plate #106-80 by installing a bellcrank pivot stud #0169 in each frame with a M3 locknut #0019.

B. Using slow cyano thread a #0107 M3x6 threaded ball and a #0105 M3x4.5 threaded ball into the flat side of one of the bellcranks #0167. Do the same thing on the other bellcrank only reversing the position of the balls so that the bellcranks are opposite each other.

C. Press all four bearings #0159 into the two bellcranks ensuring that they are square and fully seated.

D. Partially thread the M3x3 set screws #0051 into the two retaining collars #106-25.

E. Hold the left main frame with its stud facing you, and select the bellcrank which will slide on the stud with one arm vertically down containing a short ball, and other arm pivoting forward containing a long ball. Place a small amount of Loctite on the set screw threads, partially screw into collar, and retain the bellcrank by sliding the collar on the stud and tightening the set screw. Check to be sure that the bellcrank operates smoothly; if not, slightly back off retaining collar.

F. Mount the other bellcrank and collar to the right main frame in an similar way. Holding the frames together in normal orientation will show that each has a bellcrank that can be held with an arm pointing forward with a long ball on it.

Step 2. **Mounting Tailrotor Guides, Rubber Grommet Isolators and the Gyro Mounting Plates.**

Parts Required:

3	#0387 T/R Control Rod Front Guides (A & B)	Bag 3C
2	#0009 Flat Steel Washers 3mm (Small)	3C
2	#0019 Hex Locknuts 3mm	3C
3	#0029 M2.2x13 Phillips Self Tapping Screws	3C
2	#0063 M3x10 Socket Head Bolts	3C
1	#0595-1 Gyro Plate "Left"	3C
1	#0595-2 Gyro Plate "Right"	3C
2	#106-22 Rubber Grommet Isolators	3C
2	#106-24 Dampening Sleeves	3C

Refer to Drawing # 3.

A. Install the tailrotor pushrod guides #0387 into the left mainframe using three M2.2x13 Phillips self tapping screws #0029. NOTE: The two rear guides are turned so that they hold the pushrod above the Phillips screw.

B. Install the rubber grommet isolators #106-22 in the front of the top main frame plates in the same way that they were installed in the radio-battery support frames #106-12 and #106-14. Center the dampening sleeve #106-24 in the rubber grommets.

C. Install the rear gyro mounting plates as per drawing using two M3x10 socket head bolts #0063, two M3 small washers #0009 and two M3 locknuts #0019.

Step 3. **Assemble Clutch Shaft Double Bearing Block, and the Front Tail Drive Transmission**

Parts Required:

1	#0198	Start Shaft Bearing Block with Bearing (Assembled)	Bag 3D
3	#0051	M3x3 Socket Set Screws	3D
1	#0199	Start Shaft Bearing M6x19	3D
2	#0233	Front Drive Housing Halves	3D
2	#0235	Front Drive Ball Bearings	3D
1	#0237	Front Drive Retainer Collar	3D
2	#0241	Front Drive Housing Guide Sleeves	3D
1	#0231	16 Tooth front Drive Pinion	3D
1	#0559-1	Bearing Block Adapter	3D
1	#0800-6	Front Transmission Output Shaft	3D

Refer to Drawing # 3.

A. Assemble clutch shaft bearing block #0198 and bearing block adapter #0559-1. Clean the stepped area in the block and on the bottom of the adapter with alcohol or thinner. Apply a thin coat of Loctite on the adapter base. **Wipe away any excess to avoid bearing contamination.** Position the block on a flat surface (Bearing down) and place the adapter #0559("cup" side up) in place on top of the block #0198. Insert a wooden dowel or appropriately sized socket inside the cup area and tap the adapter into the block until fully inserted.

B. Apply a very thin coat of Loctite on the outside of M6x19 bearing #0199 and set it onto the adapter cup #0559-1. Use a large socket or block of wood (with a hole as to avoid contact with the bearing inner race). Tap the bearing fully in place.

C. Clean the I.D. of the two bearings #0235 and the front input shaft #0800-6 with thinner to remove any oil.

D. NOTE: At the builders discretion the bearings and shaft in this section may be glued together using locktite (red, green or blue). If you choose to do this the disassemble process will become very difficult and will require the application of heat to break down the glue.

Slide one of the bearings #0235 onto the shaft #0800-6 about half way then apply a small amount of Loctite to your finger and rub it around the shaft up next to the shoulder. Slide the bearing up next to the shoulder. Rub a small amount of Loctite where the other bearing is to be located then slide this bearing into position.

E. Lay one of the front drive housing halves #0233 on the table and push the output shaft assembly into this half. Put the other half in place and press the two halves together. Start the front transmission sleeves #0241 into the two holes in the drive housing then turn the unit over on the table with the sleeves against the table and push down on the drive housing until the housing is flush against the table.

F. Apply blue Loctite to one of the M3x3 set screws #0051 and start it in the retainer collar #0237. Slide the collar all the way up against the bearing and tighten the set screw. Ensure that the input shaft is slid completely up against the bearing. Check for binding.

G. Start the remaining two M3x3 set screws #0051 into the front drive pinion #0231 and position the pinion on the shaft and tighten down one set screw in the flat spot nearest the end just enough to keep the gear on the shaft but at the same time allowing it to slide on the shaft. Final adjustment and tightening will come later.

Step 4. **Bolting the Top Main Frame Together**

Parts Required:

1	#0182	Mainshaft Bearing Block with Bearing	Bag 3E
8	#0003	Flat Washers 3mm (Large)	3E
14	#0009	Flat Steel Washers 3mm (Small)	3E
12	#0019	Hex Locknuts 3mm	3E
12	#0077	M3x30 Socket Head Cap Screws	3E
2	#0185	Front Tailboom Support Halves	3E
1	#0540-3	Mainshaft Thrust Bearing Block with Bearing	3E
1		Front Tail Drive Transmission (Assembly)	
1		Clutch Shaft Bearing Block (Assembly)	
2		Top Mainframe Plates (Assembly)	

Refer to Drawing # 3.

Special Instructions: Do not fully tighten any of the bolts in the next few procedures until all components are installed.

A. Bolt the top mainframe side plates together with the front transmission for the tailrotor using two M3x30 bolts #0077, four M3 large washers #0003 and two M3 locknuts #0019.

B. Install the tailboom support halves #0185 using four M3x30 bolts #0077, eight M3 small washers #0009 and four M3 locknuts #0019.

C. Install the upper bearing block with recess for thrust bearing #0540-3 and lower mainshaft bearing blocks #0182 using four M3x30 bolts #0077, six M3 small washers #0009 and four M3 locknuts #0019. NOTE: The rear bolt for the upper bearing block uses no washers on either side.

D. Install the clutch shaft bearing block using two M3x30 bolts #0077, four M3 large washers #0003 and two M3 locknuts #0019.

IV. BUILDING LOWER MAINFRAME SECTIONS

Step 1. **Assembling Lower Mainframe Section and Attaching the Vertical Aluminum Frame Plate**

Parts Required:

2	#106-74 Lower Mainframe Sides	Bag 4A
2	#106-75 Aluminum Lower Frame Channels	4A
1	#0549-3 Motor Mount	4B
16	#0063 M3x10 Socket Head Bolts	4B
6	#0003 Flat Washers 3mm (Large)	4B
10	#0009 Flat Steel Washers 3mm (Small)	4B
6	#0019 Hex Locknuts 3mm	4B
1	#106-70 Aluminum Vertical Frame Plate Assembly - From Section #2	

Refer to Drawing # 4.

A. Build a right and a left main frame #106-74 by bolting aluminum lower frame channels #106-75 to outside of frames using six M3x10 cap head bolts #0063, six 3mm locknuts #0019, and six 3mm small washers #0009. The washers go on the inside of the frames. Do not fully tighten at this time.

B. Bolt the frames together using the motor mount #0549-3, six M3x10 socket head bolts #0063 and six M3 large washers #0003. The motor mount bolts go in the front set of holes for the 95 tooth main gear supplied (NOTE: These same holes are used for the 94 and 96 tooth main gear. The rear holes are used for a 90 tooth main gear). Do not fully tighten bolts at this time.

C. Slide the aluminum vertical frame plate assembly #106-70 between the lower mainframe and loosely install four M3x10 bolts #0063 with four M3 small washers #0009.

Step 2. **Assembly of the Top Mainframe Section to the Lower Mainframe Section.**
Parts Required:

2	#106-76 "Threaded" Spacers	Bag 4C
4	#106-78 "Unthreaded" Spacers	4C
8	#0009 Flat Steel Washers 3mm (Small)	4C
4	#0063 M3x10 Socket Head Bolts	4C
4	#0077 M3x30 Socket Head Bolts	4C
1	Top Main Frame Section Assembly	Section 3

Refer to Drawing # 4.

A. Slide the top mainframe assembly down into position. Place four M3 small washers #0009 on four M3x10 bolts #0063 and then start the bolts in the four holes in the front of the upper mainframe assembly and into the upper corner blocks #106-72 on the vertical frame plate. (Use Locktite).

B. Place four M3 small washers #0009 on four M3x30 bolts #0077. Hold an unthreaded spacer #106-78 between the lower mainframe and the upper mainframe on either side and pass a M3x30 bolt through the lower frame and spacer. Slide a threaded spacer #106-76 between the top mainframe and in line with the unthreaded spacer then thread the M3x30 bolt into the threaded spacer. Repeat this process for the other three bolts and four spacers. Do not fully tighten any bolts at this time.

Step 3. **Attaching the Servo Side Frame Assembly.**

Parts Required:

1	#106-18 Threaded Spacer	Bag 4D
2	#106-60 Lower Canopy Stand-off	4D
2	#0003 Flat Washers 3mm (Large)	4D
2	#0009 Flat Steel Washers 3mm (Small)	4D
2	#0019 Hex Locknuts 3mm	4D
4	#0063 M3x10 Socket Head Bolts	4D
2	#0065 M3x12 Socket Head Bolts	4D
1	Servo Side Frame Assembly	Section 2

Refer to Drawing # 2A, 2B,3 and 4.

A. Place a threaded spacer #106-18 between the servo side frames #106-10 at the top rear corner and centered between holes. Next slide the servo side frame assembly between the upper main frames #106-80 and align so that the threaded spacer is centered between the rubber grommet isolators #106-22 and dampening sleeves #106-24. Place a 3mm large washer #0003 on an M3x12 socket head bolt #0065 and install through the sleeve, and screw into the threaded spacer #106-18. Repeat process for the other side.

B. Squeeze the radio-battery support frames #106-12 and #106-14 between lower main frames #106-74 and align lowest bolt holes. Install M3x10 socket head bolt #0063 with a 3mm small washer #0009 through the front lower hole in the lower main frame and the radio-battery support on both sides. Install 3mm locknuts #0019 on the inside but do not fully tighten. Thread M3x10 cap head bolt #0063 through the top hole in the radio-battery support frame from the inside and threaded on the lower canopy standoff #106-60 (these are the longer standoffs with tapped holes at each end). Repeat procedure for the other side.

C. With the mechanics sitting on a flat surface snug up the six bolts holding the motor mount between the frames. Tighten the six bolts that hold the lower aluminum frame channels #106-75 to the lower main frames. Tighten the front and back bolts with the machine sitting on the table then turn the machine over to tighten the center bolts.

D. Tighten all eight bolts going into the frame plate corner blocks #106-72.

E. Tighten the lower canopy standoffs and the remaining four M3 bolts holding the servo side frame assembly on.

F. Tighten the four M3x30 #0077 bolts holding the lower main frame section to the top main frame section together at the rear of the machine. These bolts are going through the unthreaded spacers #106-78 and into the threaded spacers #106-76.

V. ASSEMBLY OF MAIN SHAFT AND AUTOROTATION UNITS

Step 1. **Assemble Elevator Bellcrank**

Parts Required:

1	#0157 Elevator Bellcrank	Bag 5B
1	#0107 M3x6 Threaded Steel Ball	5B
2	#0113 M3x10.5 Double Threaded Balls, Long Threads	5B

Refer to Drawing # 5 and 6.

A. Apply slow cyano to the threads on the M3x6 threaded ball #0107 and screw into the elevator bellcrank control arm #0157. Be sure that the threaded ball screws in straight.

B. Using the same technique thread the two M3x10.5 double threaded balls #0113 into the elevator bellcrank on opposite sides from each other.

C. Place the elevator bellcrank between the mainshaft bearing blocks and into its perspective position.

Step 2. **Installing the Mainshaft, Autorotation Unit with Maingear, and the Slipper Autorotation Unit.**

Part Required:

1	#0614 Extended Main Shaft (Long)	Bag 5A
1	#0209 Autorotation Hub with Bearings (Assembled)	5A
1	#0549-95 Main Gear 9.5 to 1	5A
6	#0019 Hex Locknuts 3mm	5C
4	#0051 Socket Set Screws M3x3	5C
6	#0069 Socket Head Bolts	5C
2	#0205 Main Shaft Retainer Collars	5C
1	#0540-1 Custom Thrust Bearing	5C
1	#0540-2 Custom Spacer	5C

Refer to Drawing # 5.

Optional Requirements: Teflon Base Grease #4709
Teflon Oil (Tri-Flow) #4801

NOTE: The mainshaft has a hole drilled in one end. This hole must be at the top where the rotor head goes. This end of the shaft is not hardened and will not work in the autorotation hub. Before installing the mainshaft clean well to remove any residue.

A. Examine the mainshaft thrust bearing #0540-1. If one of the outer halves of the bearing has a (O) stamped on it, this half of the bearing must be installed on the bottom. Some bearings are unmarked and may be installed either way.

B. Fill the ball retainer in the thrust bearing full of grease, teflon based #4709 and apply grease to both halves of the thrust bearing.

C. Place the thrust bearing spacer #0540-2 on top of the thrust bearing. NOTE: If you smear a little grease on the spacer it will sit still.

D. Place the thrust bearing unit between the frames and up into the bottom of the upper bearing block and hold in place with one finger.

E. Slide the mainshaft #0614 down through the top bearing block and through the thrust bearing.

F. Next place one of the retainer collars #0205 under the thrust bearing and slide the mainshaft through this.

G. Next hold the elevator bellcrank up and slide the mainshaft through this.

H. Place another mainshaft retainer collar #0205 under the elevator bellcrank and slide the mainshaft through this and the lower bearing block.

I. Start two M3x3 socket set screws #0051 into each #0205 retainer collars.

J. Noting that the maingear is two-sided and can be mounted either way, press the gear onto the shorter boss of the autorotation hub, being careful to align the mounting bolt holes. Insert the six M3x16 socket head bolts #0069 from the gear side and secure from the hub side with the six M3 locknuts #0019. Tighten securely. Lightly oil (DO NOT GREASE) the autorotation bearings. (NOTE: Tri-Flow Teflon Oil is recommended, order #4801).

Step 3. **Assemble the Slipper Autorotation Unit and Adjustment**

Part Required:

1	#0211 Plastic Autorotation Hub Spacer (Upper)	5D
1	#0551-3 Large I.D. (.393") Externally Threaded Collar	5D
2	#0551-5 M4x4 Pointed Socket Set Screws	5D
1	#0552-1 Rubber O-Ring	5D
1	#0552-2 Adjusting Ring	5D
1	#0552-4 Friction Disc	5D
1	#0552-5 Socket Head Bolt (M2.5x12)	5D

Refer to Drawing # 5.

Special tool required: Rough sandpaper and an x-acto knife.

Optional Requirements: J.B. Weld Epoxy #4853

A. Using 80-grit sandpaper, rough up the angled edge or corner of the bottom of the autorotation hub where the friction disc #0552-4 will be bonded. Also use an x-acto knife to scratch the inside of the friction disc. NOTE: Do not apply to much pressure to the friction disc as it is thin and will bend easily. Also clean both parts with a paper towel and some thinner.

B. Apply blue Loctite to the two M4x4 pointed socket set screws #0551-5 and start them in the externally threaded collar #0551-3.

C. Place the plastic auto hub spacer # 0211 on top of the main gear and auto hub and then slide the unit up onto the mainshaft.

D. Slip the threaded collar on the mainshaft next and run the pointed set screws #0551-5 into the hole going through the mainshaft. Tighten securely.
NOTE: The set screws when tightened should be inside the threads of the threaded collar #0551-3.

E. Apply blue Loctite to two M3x3 set screws #0051 in the lower mainshaft retainer collar. At this time tighten up the bottom mainshaft bearing block bolts.

F. Place your middle finger on either hand on the bottom of the mainshaft. Place your thumb on the same hand on top of the bottom mainshaft retainer collar and squeeze together.

This will pull the mainshaft all the way up and take the vertical play out of the maingear. Tighten up one of the set screws in the collar and then do two things; Spin the main gear while holding the mainshaft to ensure that it spins freely. Next check for vertical play in the main gear by holding it on both sides with both hands and try to move the gear up and down. The ideal situation is where there is virtually no vertical play but at the same time the gear spins freely. Once you are satisfied tighten both set screws in the retainer collar securely.

G. Clean the inside of the adjusting ring #0552-2 and cyano the rubber O-ring #0552-1 in place. Start the socket head bolt #0552-5 in the adjusting ring.

H. Mix J.B.Weld #4853 and use a small straight screwdriver and apply a thin even coat to the roughed up portion of the auto hub. Apply a thin even coat to the friction disc. Place the friction disc in place on the bottom of the auto hub and seat as squarely as possible. Put some grease on your finger and rub it all over the O-ring, then thread the adjusting ring up on the threaded collar and up against the friction disc. Once the O-ring makes contact, tighten it one-half turn more then tighten the socket head bolt. Spin the maingear while holding the mainshaft about two turns. This will seat the friction disc squarely to the auto hub.

I. At this time the top mainshaft bearing block should still be slightly loose. You will notice if you grab hold of each end of the block it will move up and down slightly. This will help to get the mainshaft thrust bearing loaded properly. Apply some blue Loctite to two M3x3 set screws in the upper mainshaft retainer collar #0205. Pull this collar all the way up making sure that the mainshaft thrust bearing is fully seated in the bottom of the bearing block. Push down on the top of the mainshaft with your thumb while pulling up on the upper retainer collar with your middle finger. Tighten both set screws securely. Push down on the upper bearing block while tightening the two M3x30 bolts. Make sure that the M3 locknut on the back bolt is adjusted so that there is a flat surface on the top and bottom of the nut, as to allow the antirotation bracket # 106-82 to slide around this nut.

J. Remove the M3x3 set screws from the front tailrotor pinion gear #0231 and apply Loctite. Re-install screws but do not tighten.

K. Push the transmission down into the main gear so that it is seated. Slide the pinion gear back on the shaft till it rubs the step on the maingear then slide the pinion forward about a half of a millimeter then lightly tighten the set screw against the flat. View the gear mesh from underneath the top mainframe. Rotate the maingear 360 degrees and make sure that the pinion gear does not get up against the back edge of the maingear. There should be some clearance all the way around. Once satisfied tighten both set screws securely.

L. Next adjust the gear mesh between the front transmission and the maingear. You want no play between the gears but no binding or tight spots. If either exists, loosen the mesh slightly. Ensure that the universal joint end of the shaft is pointed straight down the tailboom. To check this find a shaft or drill bit that will fit into the universal joint and check to see if it is centered between the tailboom support halves. Once both of the alignments are done tighten the two M3x30 bolts and re-check alignment. Sometimes it will change slightly when you tighten the bolts.

VI. COLLECTIVE AND ELEVATOR PUSH-PULL ASSEMBLY

Step 1. **Installing the Collective and Elevator Pivot Studs**

Parts Required:

1	#106-90	Special Pivot Stud	Bag 6A
2	#0159	M3x7 Bearings	6A
2	#0553-7	Pivot Studs	6A
1	#106-28	Bellcrank Standoff with M3x16 Set Screw	6A
1	#106-94	Spacer for Pivot Stud	6A
2	#0019	Hex Locknuts 3mm	6A
1	#106-84	Collective Arm with Bearings(#0553-2)	6A
1	#106-91	Elevator Swing Arm with Bearing(#0553-2)	6A

Refer to Drawing # 6.

Special Instructions: Examine drawings of the collective system carefully.

A. Slide the special pivot stud #106-90 for the elevator push-pull bellcrank and collective arm pivot through the top mainframe plates #106-80, placing the spacer #106-94 between the frames. Apply a small amount of blue Loctite to the threaded end of the pivot stud and then thread on the standoff #106-28 for the collective arm. Tighten using a 3/8" or 9.5mm wrench.

B. Install pivot studs #0553-7 on the main collective arm #106-84 and the elevator swing arm #106-91 using two #0019 M3 locknuts to secure. **NOTE:** The top of the elevator swing arm is distinguished by a radius in the arm next to the pivot stud which allows forward cyclic movement of the elevator bellcrank #0157. The 3mm shaft on the stud, which is for the M3x7 bearings in the elevator bellcrank, should be on the inside of the arms.

C. Clean the I.D. of the M3x7 bearings #0159 and the shafts on the studs #0553-7. Apply a small amount of blue Loctite to the shafts then press the bearings all the way on the shafts.

Step 2. **Installing the Collective and Elevator Pivot Studs**

Parts Required:

4	#0003	Flat Washers 3mm (Large)	6B
1	#0009	Flat Steel Washer 3mm (small)	6B
1	#0015	Hex Locknut 2mm	6B
3	#0019	Hex Locknuts 3mm	6B
1	#0046	M2x16 "8.8" Slotted Machine Screw	6B
1	#0061	M3x8 Socket Head Bolt	6B
3	#0063	M3x10 Socket Head Bolts	6B
2	#0361	M2 Steel Balls	6B
2	#0446-4	Shims (.003 thick)	6B
1	#106-86	Collective Arm Doubler with Bearing(#0553-2)	6B
1	#106-92	Collective Arm Brace	6B

Refer to Drawing # 6.

A. As per the drawing loosely bolt the collective arm #106-84 to the collective arm doubler #106-86 using two M3x10 socket head bolts #0063, two 3mm large washers #0003 and two

3mm locknuts. The washers go between the arms. Place one steel ball #0361 on a M2x16 (8.8) slotted machine screw #0046. Hold a large 3mm washer between collective arms and push the screw through the inside hole. Place another steel ball #0361 on the screw #0046 and start a 2mm hex nut #0015 but do not tighten at this time.

B. Slide the assembly onto the collective arm bellcrank standoff #106-28. At the same time, ensure that the pivot stud #0553-7 with the M3x7 bearing goes into the elevator yoke #0157. Slide the washer #0009 onto the M3x16 set screw and push it against the bearing on the collective arm doubler. Start a 3mm locknut #0019 on the set screw but do not fully tighten at this time.

C. Slip the collective arm brace #106-92 through the kidney slot from the right hand side of the machine and loosely bolt the brace to collective arm using an M3x10 socket head bolt #0063 with a 3mm large washer between the collective arms. **NOTE:** Groove in collective arm brace should be centered between the main frames.

D. Tighten the 3mm locknut on the collective arm bellcrank standoff and the two M3x10 socket head bolts #0063 with 3mm locknuts. Take the 2mm hex nut off of the slotted machine screw #0046 and apply blue Loctite. Tighten, being careful to remember that this is a 2mm screw.

E. Slide the elevator swing arm #106-91 onto collective arm special pivot stud #106-90 and, at the same time, slide the pivot stud #0553-7 (with bearing) in to the elevator yoke #0157.

F. Install a M3x8 socket head bolt #0061 through the swing arm and into the arm brace #106-92 between the collective arm and swing arm. Tighten the M3x10 socket head bolt in the other end of the spacer.

G. Hold the main shaft still with your hand while operating collective up and down with your left hand. The collective system should operate freely.

H. Due to forming variations and the quantity of parts involved in the collective system, it may be necessary to insert a small shim #0446-4 or two on either end of the collective arm brace #106-92 between either control arm. This shim is optional and rarely needed. Its use will depend entirely on your assembly and alignment of the elevator yoke #0157 and the collective mechanism.

Step 3. **Assembly of Elevator Push-Pull**

Parts Required:

1	#0560-6 Special Control Arm/with Bearing #0560-5	Bag 6C
2	#0015 Hex Nuts 2mm	6C
1	#0051 M3x3 Socket Set Screw	6C
2	#0103 M2x5 Threaded Steel Balls	6C
1	#0107 M3x6 Threaded Steel Ball	6C
1	#0446-4 Shim (.003 Thick)	6C
1	#106-25 Retainer Collar	6C

Refer to Drawing # 6.

A. Study the drawings to determine which side the steel threaded balls are inserted on the special control arm #0560-5 on the elevator push-pull unit. Bolt the two M2x5 threaded balls #0103 to the special control arm using Loctite and two 2mm hex nuts #0015. Apply

Loctite to the M3x6 threaded ball #0107 and insert it into the special control arm and tighten.

B Slide the .003 shim #0446-4 onto the special pivot stud #106-90, followed by the special control arm and then the retainer #106-25. Apply Loctite to the M3x3 set screw #0051. Thread it into the retainer collar and tighten.

VII. MAIN SHAFT ASSEMBLY

Step 1. **Assembling Swashplate**

Parts Required:

1	#0217	Aluminum Swashplate (10mm)	Bag 7A
4	#0051	M3x3 Set Screws	7B
1	#0067	M3x14 Socket Head Bolt	7B
3	#0107	M3x6 Threaded Steel Balls	7B
4	#0109	M3x8 Threaded Steel Balls	7B
2	#0133	Plastic Ball Links (Long)	7B
1	#0159	M3x7 Ball Bearing	7B
1	#0227	M2x38 Lower Swashplate Control Rod	7B
1	#0555-1	Special Ball with 3mm hole	7B
2	#0687	Tail Rotor Blade Mount Bearing Spacers	7B

Refer to Drawing # 7.

A. Apply a small amount of Loctite to the four M3x3 set screws #0051 and install them into the outer ring of the swashplate. These set screws are for adjusting the play out of the radial bearing. Lightly tighten up two set screws opposite each other and then check to make sure that the bearing doesn't get notchy. Once these two set screws are set the other two can be set in the same manner.

B. Examine the swashplate #0217 for control ball positioning. Using a small amount of Loctite on each, thread four M3x8 threaded balls #0109 on the inner ring of the swashplate at 90 degrees apart. Using Loctite mount three M3x6 threaded ball #0107 in three of the four holes in the outer ring of the swashplate.

C. Stack the following parts on the M3x14 socket head bolt #0067, one M3x7 ball bearing #0159, one special sleeve #0687, one special ball #0555-1 with a 3mm hole and one more special sleeve #0687.

D. Snap one of the long plastic ball links #0133 onto the special ball #0555-1. Apply a small amount of blue Loctite to the M3x14 bolt and install it in the remaining hole in the outer ring of the swashplate and tighten.

E. Start the remaining ball link #0133 onto the M2x38 pushrod #0227 then thread the pushrod into the other ball link on the swashplate. Screw the ball link together equally until there is 30mm between the inside ends of the ball links.

F. Slide the swashplate down the mainshaft and snap the ball link onto the outer ball on the M3x10.5 threaded double ball #0113 on the back of the elevator bellcrank #0157.

Step 2. **Installing the Swashplate Antirotation Bracket**

Parts Required:

1	#106-82 Support Bracket	Bag 7C
1	#0003 Flat Washer 3mm (Large)	7C
3	#0019 Hex Locknuts 3mm	7C
2	#0061 M3x8 Socket Head Cap Screws	7C
1	#0089 Hex Head Bolt M3x10	7C
1	#0555-2 Slotted Plate	7C

Refer to Drawing # 7.

A. Bolt the slotted plate #0555-2 to the antirotation bracket #106-82 using a M3 hex bolt #0089, a M3 large washer #0003 and a M3 locknut #0019. The M3 hex bolt goes through the slotted plate, the plate goes up against the inside of the bracket, the M3 large washer goes on the outside of the bracket followed by the M3 locknut. Do not fully tighten. Slide the bracket up into position behind the swashplate making sure the ball bearing goes between the slotted plate. Bolt the bracket in place using two M3x8 #0061 socket head bolts and two M3 locknuts. Notice that the slotted plate will slide from side to side and can also be leaned at the top. This adjustment is to allow the swashplate timing to be altered. Simply put, moving the slotted plate from side to side or leaning the top of the plate changes the way the model follows cyclic commands. Initially set the plate up in the center and parallel with the main shaft. Ensure that the M3 hex bolt is very tight. Once tightened run a small bend of thin zap along the slotted plate where it meets the support bracket.

Step 3. **Assembly of Wash-Out Unit**

Parts Required:

1	#0219 Wash-Out Center Hub	Bag 7D
2	#0097 Special Bolts M3x22	7D
2	#0109 M3x8 Threaded Steel Balls	7D
2	#0223 Wash-Out Special Links	7D
4	#106-02 M3x7 Flanged Bearings	7D
2	#106-05 Machined Wash-Out Control Arms	7D
4	#106-06 Small Flanged Bearings for Pivot	7D
2	#106-07 Pivot Pins	7D
5	#106-08 Circlips	7D

Refer to Drawing # 7.

NOTE: One extra #106-08 circlip is included.

A. Take the two machined washout control arms #106-05 and two M3x8 balls #0109(long shank) and thread a ball into the hole in the long end of each arm from the flat side. Use Loctite.

B. Press the M3x7 flanged ball bearings #106-02 into both sides of the center holes in both control arms using red or blue Loctite. Do not allow the Loctite to get into the bearings.

C. Using two special washout arm bolts #0097, and carefully follow the drawing , screw the arms on the washout center hub #0219. (Suggestion: squarely start the thread of each bolt into its hole in the hub part way first without the arm.) The control ball should face inward. Tighten entire assembly until there is no lateral play and no bearing drag.

D. Locate four #106-06 flanged bearings, press two into each end of the control arms #106-05. Seat squarely in place. Using two pivot pins #106-07 assemble the wash-out special link #0223 to each control arm through bearings #106-06. Their orientation is shown on the drawing. Note that they mount on the short end of the arms, projecting inward. The pins press in place centered in the links. Secure each end of the pins using circlips #106-08. The special links #0223 should have no end play and pivot freely. If they do not pivot freely slide an X-acto blade or razor blade around the pin in between the plastic link and the washout arm. This will slightly remove any plastic burrs.

E. Slide assembled wash-out unit down onto the mainshaft, snap the two #0223 wash-out links onto any two opposite #0109 steel balls on the inner ring of the swashplate.

VIII. INSTALLING ENGINE ASSEMBLY AND FAN SHROUD ASSEMBLIES

Step 1. **Mounting Flywheel and Clutch Assembly**

Parts Required:

1	#0255	Cooling Fan (Assembled)	Bag 8A
1	#0267	Centrifugal Clutch & Shaft	8B
1	#0275	Clutch Bell with Bearings, Pinion, Liner (Assembled)	8B
1	#0007	M6.6x12.3 Flat Steel Washer	8C
2	#0081	M4x16 Socket Head Bolts	8C
1	#0264	Fan Drive Collet 1/4" O.S. 61 SFN-H	8C
1	#0273	Clutch Spacer Washer	8C

OPTIONAL PART: #0262 (O.S. - "SX .61), 8mm or 5/16" Collet, #0265 (Enya .61) 7mm Collet.

Refer to Drawing # 8.

Special Tools Required: 1 Dial indicator or equivalent (for testing fan run out).

A. Although not essential, it is suggested that the engine to be used receive a suitable break-in run prior to installation. Set the throttle barrel stop to allow full carburetor shut off at the low end and retain (or record) the idle and high speed mixture needle settings. These are more easily done on a test bench.

B. The precise centering of the fan and clutch assembly is achieved by the use of a special collet #0264 provided in the XL-Pro kits that has a .250" bore. This will fit the majority of engines commonly selected for helicopter use. Measure the shaft diameter of your engine and if it differs, contact your dealer or Miniature Aircraft USA direct to obtain the correct collet. This is essential for a true running engine/shaft assembly and a vibration-free helicopter! (Radio and servos live short, unhappy lives in high vibration applications!) NOTE: It may be necessary to cut approximately 4.0mm from the top of the engine crankshaft for clearance of main clutch unit. The maximum allowable length of the crankshaft is 21mm. When cutting, cover all open engine surfaces.

C. Remove the nut and washer from your engine. Place the #0255 cooling fan on the engine shaft. Place the proper fan drive collet #0264(in kit) or #0262 (O.S. SX Collet) or #0265(7mm, optional) on the engine shaft, **Small** O.D. end down. Center the fan to engage the collet, slide #0007 engine washer and replace the engine prop nut (the use of Loctite is recommended). Make sure the collet fully engages the fan and tighten securely, using Loctite. **Hint:** Coat the outside and inside of the collet with thin oil to ease disassembly later.

D. Using whatever device is available, - a machinist's dial indicator is preferred. Determine that the fan runs square and true when engine shaft is rotated. If it does not, remove fan and collet and rotate them to a new position and reinstall. This is an important step. If a dial indicator is used, acceptable alignment is shown by less than .06mm (.002") excursion of the needle during a full rotation of the engine shaft. A new fan hub flywheel puller which enables quick and easy removal of X-Cell cooling fan hubs, without damage to vital components is available through Miniature Aircraft USA. Order part #0554. If difficulties persist in aligning the fan unit, re-facing the knurled engine prop drive with a lathe will help the alignment process. Many of the knurled engine prop drives do not run true.

E. After alignment, the prop nut must again be tightened very securely to prevent slippage during engine start or backfire. A good method of tightening is to have a helper grasp the fan with a heavy cloth wrapped around it while the nut is tightened with an appropriate socket wrench. (NOTE: A slight shift in dial indicated reading may occur as the fan nut is increasingly tightened. It is important that the engine nut be quite tight; however, caution must be used when dealing with 1/4" crankshaft sizes to avoid breakage.)

F. Select the start/clutch shaft #0267,(used in step I-1), make sure its mounting face is clean and install it on the cooling fan, using two M4x16 #0081 socket head bolts. Now check it for alignment at the clutch shaft base by loosening the clutch bolts and shifting the clutch or by rotating the clutch 180 degrees and re-tighten. Once the base is aligned, the start shaft tip can be checked and aligned by applying pressure with a small pipe or suitable tool that fits over the shaft until true. Once aligned, remove the screws one at a time, apply Loctite, and replace. Tighten securely and re-check alignment.

G. Slide the clutch spacer #0273 over the clutch shaft, followed by the clutch bell assembly #0275.

Step 2. **Install and Align Engine in Frames**

Parts Required:

1	#4677-1 Female Universal Starter Cup	Bag 8D
2	#0057 M4x4 Socket Set Screws	8D
4	#0080 M4x14 Socket Head Cap Screws	8D
4	#0549-4 Motor Mount Spacers .60 Size	8D

Refer to Drawing # 8.

A. The following is a listing of gear ratios, the number of shims to be used and which holes in the mainframe to use.

Engine to Main Rotor Ratio			
9:1	#0191	**2 Shims per side**	**Mount in rear holes**
9.4:1	#0549-3	**No Shims**	**Mount in forward holes**
9.5:1	#0549-3	**1 Shim**	**Mount in forward holes (incl. with XL-Pro Kit.)**
9.6:1	#0549-3	**2 Shims**	**Mount in forward holes**

B. Remove the previously installed clutch shaft bearing block in the main frames.

C. The motor mount can be flipped over if necessary to vary it's height in the mainframes. If you are using an O.S. engine the two holes next to each other will be on the top side of the motor mount.

D. Slide the engine up through the frames from the bottom and depending on the gear ratio selected place the proper number of engine shims #0549-4 between the engine and the motor mount and install the four M4x14 socket head bolts #0080. Tighten the bolts enough to hold the engine against the motor mount still allowing you to move the clutch shaft from side to side.

E. Slide the clutch shaft bearing block into position with round portion of the bearing block to the bottom. Push one M3x30 bolt #0077 through the bearing block to locate the vertical height of the bearing block.

F. Adjust the height of the engine by sliding the motor mount up and down. There should be between one half and three fourths of one millimeter of vertical play in the clutch bell.

G. Temporarily snug up the M4x14 bolt holding the engine to the motor mount then remove the clutch shaft bearing block.

H. Adjust the gear play between the maingear and the pinion gear. You want as little play as possible without having any tight spots. Once adjusted, tighten the six bolts holding the motor mount in the frames.

I. To ensure that the clutch shaft doesn't get pulled off center when tightening the clutch shaft bearing block, measure with a set of calipers or metal ruler the distance from the clutch shaft to the aluminum vertical frame plate. Once the distance is known reinstall the clutch shaft bearing block and tighten the two M3x30 bolts. Measure the distance again to ensure that the clutch shaft didn't move.

J. Slightly loosen the four M4x14 bolts in the motor mount and allow the engine to center itself then re-tighten the four bolts.

K. Press the female universal starter cup #4677-1 onto the clutch/start shaft until the end of the shaft is flush with the top side of its through hole. Do not press further as the shaft may interfere with the male universal during starting. Secure with Loctite and (2) M4x4 socket set screws #0057.

L. Install the carburetor at this time.

Step 3. **Mounting Male Universal Uni-Lock onto Starter Extension**

Parts Required:

1	#4677-2 Male Uni-lock Adapter	Bag 8E
2	#0034 Phillips Countersunk Screw M2.9x13	8E

Optional Parts Required:

1	#4681 Starter Extension

A. Install the #4677-2 male universal into the cup side of the starter extension (Miniature Aircraft USA #4681 or your existing Miniature Aircraft USA extension). Fully press the universal in place (on existing extensions be sure to remove the rubber cup). Drill (2) holes 180 degrees apart through the aluminum and into the Delrin universal. Using a #44 (.086" or 2.2mm) drill about 13.0mm from the end of the aluminum cup. Countersink (for flush head screws provided) with light pressure from a #1 (.228" or 5.8mm) drill. Install (2) #0034 2.9x13 phillips self tapping flathead screws (provided).

Operation of the Uni-lock Starter System is quite simple. Engage the Delrin ball fully inside the female unit on the mechanics. No pressure is required. Rotate the extension clockwise until the engine nears top dead center (just stop when a little resistance is felt). Proceed to start the engine. As soon as the engine speed exceeds the starter speed (which is virtually immediately), the Uni-lock ball will "feed" out of the adapter as you lift the starter. Any possible body damage is eliminated. To avoid damaging the appearance of the hardcoat surface of the female universal, do not engage the starter button before it is fully inserted.

Step 4. **Installing the Fan Shroud Assembly**

Parts Required:

1	#0548-5 Cooling Fan Shroud	Bag 8A
2	#0003 Flat Washers 3mm (Large)	8F
3	#0009 Flat Washers 3mm (Small)	8F
2	#0019 M3 Locknuts	8F
5	#0029 M2.2x13 Philip Screws Self Tapping	8F
4	#0061 M3x8 Socket Head Bolts	8F
1	#0067 M3x14 Socket Head Bolt	8F
1	#0357 Plastic Pivot Bushing	8F
1	#106-68 Fan Shroud Bracket	8F

Refer to Drawing # 8.

A. The fan shroud bracket #106-68 should be installed on the left hand side of the machine. Study the drawing to ensure proper mounting of the bracket. The bracket goes on the inside of the lower mainframe side. Use two M3x8 socket head bolts #0061, two M3 small washers #0009 and two M3 locknuts #0019 to secure the bracket to the frame. Do not fully tighten at this time.

B. Install both halves of the fan shroud #0548-5 into position and then screw the halves together using five, M2.2x13 Phillips screws #0029 from the right side.

C. Place a M3 small washer #0009 on the M3x14 bolt #0067, push the bolt through the front hole in the bracket, then place the bracket spacer #0357 on the bolt and then screw the bolt into the fan shroud. Do not fully tighten.

D. Place a M3 large washer #0003 on both M3x8 bolts #0061, then screw them into the fan shroud lower mounts.

E. Align the final shroud so that it is square to the fan and then tighten all previously installed hardware.

IX. ASSEMBLE LANDING GEAR

Step 1. **Assemble Landing Gear and Install**

Parts Required:

2	#0153 Skids	Bag 9A
2	#0151 Struts	9A
4	#0019 M3 Locknuts	9B
4	#0071 M3x18 Socket Head Bolts	9B

2	#106-66 Graphite Gear Braces	9B

Refer to Drawing # 9.

Special Tool Required: Heat gun (Monokote type) or a source of heat such as boiling water.

A. Examine view on the drawing to determine orientation of the struts #0151 and skids #0153. Note that the struts sweep forward.

B. Wearing a glove or using a cloth for protection from heat, pick up one flexible strut and, with a skid conveniently at hand, heat one end of the strut until the skid can be pushed into the hole from the front without undue pressure. **Do not overheat!** Push the skid through until its end projects rearward through the strut exactly 220mm.

C. Pick up the second strut, heat it the same way and press it on the skid until the skid projects rearward from it exactly 75mm. Again check drawings for orientation. The distance between the bolt holes from the front to the rear strut should be 145mm.

D. Grasp the forward strut again, heat its opposite end and, in a similar fashion, press the second skid through this hole. Continue until it is about to engage the second strut. Now heat the rear strut and, before the front one cools, slide the skid through both into its final position.

E. Install the landing gear with graphite landing gear brace #106-66 between the landing gear and the lower aluminum frame channels #106-75. Use the four M3x18 bolts #0071 and M3 locknuts #0019. NOTE: The rear landing gear bolts are inserted in the holes closest to the back edge of the mechanics, the front bolts in the third hole from the front.

X. ASSEMBLE THE TAILROTOR TRANSMISSION

Step 1. **Assemble Tailrotor Hub and Blade Holders**

Parts Required:

		Bag 10
2	#0019 Hex Locknuts 3mm	10B
2	#0073 M3x20 Socket Head Bolts	10B
2	#0103 M2x5 Threaded Steel Balls (Long Thread)	10B
2	#0299 M4x10 Ball Bearings	10B
2	#0439 M6x10 Ball Bearings	10B
2	#0453 Tail Rotor Blade Mounts	10B
2	#0457 T/R Thrust Bearings	10B
2	#0446-2 Special Machined Nuts	10B
4	#0446-3 Special Shims .001	10B
4	#0446-4 Special Shims .003	10B
1	#0446-1 One-Piece Machined 4mm Stud Steel Tail Rotor Hub	10B

NOTE: Part #0447-1, #0447-2, #0001 and #0449 found in section "B" will be installed after section 10-D is completed.

Refer to Drawing # 10.

NOTE: Remember to clean all steel components before applying Loctite.

A. Take the two tailrotor blade mounts #0453 and thread the M2x5 threaded balls #0103 into the outboard holes, using slow cyano.

B. Press the M4x10 ball bearing #0299 into the blade mounts, on the root end, seating them squarely and fully.

C. Pack the #0439 ball bearings full of grease and the wipe off any excess. Press the bearing onto the special nuts #0446-2 and seat them fully. NOTE: If more than thumb pressure is required, apply pressure to the inner race of the bearing only.

D. Lay out the two thrust bearing assembles #0457. Use two spare 4mm bolts for greasing and assembling the thrust bearings. Each bearing has one race that has a smaller I.D. Place the small I.D. halves on the two bolts with the ball grove facing up. Apply grease all the way around the groove. Next place the ball retainers with the cup sides up onto the balls. Apply grease to the top sides of the bearing race that has a larger I.D.. Place the other halves of the bearings on the bolts completing the assemblies, wipe off any excess grease.

E. Slide the blade holders onto the one piece machined steel T/R hub #0446-1 followed by the thrust bearings. NOTE: The large I.D. half of the thrust bearings has to go on the steel hub first, leaving the small I.D. half next to the shims #0446-3 or #0446-4 and the special nut #0446-2.

F. Thread the special nuts up onto the steel hub and lightly tighten. Check for end play in the blade holders. NOTE: If there is end play in the blade holders it will have NO adverse effect on the operation of the tailrotor due to centrifugal force loading the thrust bearing as it was designed to do. However two different sizes of shims are provided if you would like to remove some of the end play. NOTE: A small amount of end play must exist so as not to put the bearing in a bind. If shims are used, place an equal amount on each side because it is important to keep the distance equal between the center of the hub and each blade pivot hole.

G. Temporarily insert the #0073 M3x20 socket head bolts into the blade mounts outer holes. Retain in place using one #0019 M3 locknut on each bolt. It is only necessary to finger tighten the nut in place.

Step 2. **Mount and Balance Tail Rotor Blades**

Parts Required:

2	#3694-3 Carbon Fiber Tail Blades	Bag 10A
4	#3694-1 Nylon Washers	10B
2	#3694-2 Knurled Pivots	10B

Refer to Drawing # 10.

A. Remove from section (10A) the graphite tailrotor blades #3694-3, four plastic spacers #3694-1 and two knurled pivot bushings #3694-2. Press into each blade pivot hole one each #3694-2 pivot bushings. Insert one #0073 M3x20 socket head bolt (previously installed in step 1.) partially threw the blade pivot hole in the tail rotor blade mount #0453. From the inside of the blade mount slide one #3694-1 plastic bushing followed by a graphite tail blade and another #3694-1 plastic bushing. Press the socket head bolt entirely through the blade mount. Secure using one #0019 3mm locknut. Tighten only enough that the tail blade can rotate with slight pressure. NOTE: If the tail blade and mount are held

horizontally the tail blade will not fall.

NOTE: Re-check drawing for correct tail blade directional orientation for a clockwise rotation. The tail rotor pivot bolts #0073 should be facing inwards.

Repeat entire procedure for the other tail blade.

B. To balance the entire tail rotor assembly the #0429 tail rotor output shaft found in section 10-D may be used as a balance bar. Lightly grease the output shaft and slide the #0449 rubber dampener half way over the shaft. Clean the exposed shaft of grease . Slide the assembled tail rotor hub onto the rubber dampener.
NOTE: To accurately balance the tail rotor, the tailrotor blades must extend straight out from the hub and parallel to each other.
Set this entire unit in between two "glass" glasses on a flat surface. If there is an imbalance the heavy blade will hang lower. Add weight in the form of a narrow strip of colored tape or preferable use a small 3mm washer on the blade pivot bolt of the lighter blade, to balance. (If the washer is used trim the washer with a pair of cutters to achieve the proper weight needed.) The tail should remain in any position if balance is correct. Proper blade balance is essential. Remove the output shaft #0429 and rubber dampener #0449.

Step 3. **Assemble Pitch Slider and Bell Crank**

Parts Required:

1	#0015	M2 Hex Nut	10C
2	#0041	M2x8 Slotted Cheese Head Machine Screws	10C
1	#0095	Special Bolt Tail Rotor Bellcrank	10C
1	#0101	M2x5 Thread Steel Ball(Short Thread)	10C
1	#0103	M2X5 Threaded Steel Ball (Long Thread)	10C
2	#0133	Long Ball Links -- Long	10C
2	#0159	M3x7 Ball Bearings	10C
1	#0435	Brass Tail Rotor Control Slider	10C
1	#0437	Plastic Control Slider Ring	10C
2	#0439	M6x10 Ball Bearings	10C
1	#0441	Plastic Pitch Plate - Tail Rotor	10C
1	#0443	Snap on Retainer Pitch Plate	10C
1	#0445	T/R Bellcrank	10C

Refer to Drawing # 10.

A. Begin by threading the M2x5 short threaded ball #0101 into the side hole of the control ring #0437. Use cyano and thread the ball squarely in place.

B. Place the two #0439 ball bearings (M6x10) on a clean paper with the balls visible. Lightly grease each.

C. Slide one bearing on the #0435 brass control slider. Lightly slide the control ring over the slider, followed by the other bearing, and finally the #0441 pitch plate small end first. Press together until the bearings squarely and completely enter the recesses in the control ring. Do not force.

D. Examine the #0443 pitch plate retainer, noting its four inside spring fingers and cupped shape. It will be pressed on the end of the brass slider to retain this subassembly, but this must be done with great care to ensure that the control ring is neither to tight nor to loose.

The control ring bearings are precise and delicate but necessary for a tight play free tail rotor control.
Cut a hole just large enough to go over the end of the brass slider in a small piece of very thin plastic such as the flap from a plastic sandwich bag (Saran Wrap, etc) and place it over the slider against the pitch plate face. Rest the slider vertical against a wood or cardboard surface, pitch plate up, and press the retainer in place, cupped face **UP**. A piece of scrap wood with an appropriate drilled hole in it will be very helpful for this operation. Continue pressing the retainer in place until it seats against the thin plastic shim. Carefully tear and pull the plastic out. This should provide a subassembly in which the control ring is free to rotate smoothly but with negligible end play. Apply cyano to retainer clip where it touches the pitch control plate.

E. Screw #0133 ball links to the pitch plate using M2x8 machine screws #0041. Just seat the screws, so that the links can rotate with firm pressure.

F. Press the M3x7 ball bearings #0159 into the holes in the tail rotor bellcrank #0445, using the special bellcrank bolt #0095 to keep the bearings aligned during the process.

G. The control bellcrank #0445 has three 2mm holes in the control arm. In most cases the center hole provides the most efficient tail rotor control. From the bottom side of the tail rotor bellcrank #0445 thread in one #0103 M2x5 threaded steel ball (long threads). Secure in place with one #0015 M2 hex nut. Use Loctite.

Step 4. **Assemble the Gearbox**

NOTE: At the builders discretion the bearings and shaft in this section may be glued together using locktite (red, green or blue). If you choose to do this the disassemble process will become very difficult and will require application of heat to break down the glue.

Parts Required:

1	#0800-7 T/R Input Shaft 5.0 x 37.3mm	Bag 10D
4	#0025 Phillips Pan Head Self Tapping Screws M2.2x6.5	10D
4	#0051 M3x3 Socket Set Screw	10D
1	#0053 M3x5 Socket Set Screw	10D
1	#0421-A T/R Gear Box Housing	10D
1	#0421-B T/R Gear Box Housing	10D
4	#0425 M5x13 Tail Gear Box Ball Bearings	10D
1	#0429 T/R Output Shaft	10D
1	#0431 E-Clip - Output Shaft	10D
1	#0433 Plastic Gear Spacer - Output Shaft	10D
1	#0547-1 Bevel Gear (Tail Rotor Gear Box) Large	10D
1	#0547-2 Bevel Gear (Tail Rotor Gear Box) Small	10D

Refer to Drawing # 10.

A. At this time clean the input shaft #0800-7 and the output shaft #0429, the inner race on the four ball bearings #0425 and the two bevel gears.

B. At builders discretion apply a small amount of blue Loctite to input shaft #0800-7 next to the delrin coupler. Slide one of the bearings #0425 all the way up against the delrin. Lay the lower half of the T/R gear box #0421-A on the table and hold the input shaft over the T/R gear box half and apply a small amount of Loctite where the second bearing goes and slide the bearing into position. Apply blue Loctite to the two M3x3 set screws #0051 and

start each in to the large bevel gear #0547-1. Place the gear on the shaft and run one of the set screws down and make sure that it is on the flat. Push this assembly down into the lower T/R gearbox half and adjust the gear so that no end play exist but without binding the two bearings. Tighten the two set screws thoroughly and set aside this assembly to cure for a few minutes.

C. Snap the E-clip #0431 into the groove on the T/R output shaft #0429. Apply a small amount of Loctite to the small portion of the shaft beside the E-clip. Slide one of the two remaining bearings #0425 onto the shaft and up against the E-clip.

D. Apply blue Loctite to the two remaining M3x3 set screws and start them onto the small bevel gear #0547-2. Slide this gear onto the shaft teeth first and run one of the set screws down into the flat spot on the shaft. Slide the plastic spacer #0433 on next followed by the remaining ball bearing #0425. Apply Loctite where the bearing will sit. Lay the other T/R gear box half #0421-B on the table and place the output shaft into its perspective position. Once again adjust the gear and tighten so that there is no end play and no binding in the bearings. **Caution:** This is a small gear, do not over tighten.

E. After curing apply a liberal amount of grease to both gears. With the two shafts in there respective positions bring the two T/R gearbox halves together and install the four M2.2x6.5 phillips screws #0025. **NOTE:** Be sure to install the screws from the correct side. Check for binding, if any - sand plastic spacer between output gear and bearing and reposition gear.

F. Slide the T/R pitch slider onto the shaft. (Pre-Assembled in step 3)

G. Engage the control ring ball in the clip end of the bellcrank #0445 and squarely thread the special bolt #0095 into the gear housing #0421 from the bottom. Tighten the bolt until there is no play or bearing drag.

H. Temporarily install the M3x5 set screw #0053 into the end of the T/R output shaft #0429. Do not tighten at this time.

Step 5. **Install Assembled Tail Rotor Hub**

Parts Required:

2	#0447-1 Locking Clips (Circlips)	Bag 10E
1	#0447-2 Groove Pivot Pin	10E
1	#0449 Rubber Dampener	10E
2	#0001 Flat Washer 2mm (small)	10E

Refer to Drawing # 10.

A. Press the silicone dampening #0449 sleeve onto the output shaft about 10mm. Use a 1.5 Allen wrench or a small drill to pierce through the silicone dampener and through the cross hole in the output shaft. Temporarily tighten the M3x5 set screw #0053 against the Allen wrench or drill bit to ensure that no burrs exist in the shaft. Loosen the set screw and remove the allen wrench or drill bit. Check with the drawing to ensure the proper orientation of the delta tail hub before pushing it over the silicone sleeve. Hold the hub with the pin hole lined up with the hole in the output shaft then push the hub into position, a small amount of grease maybe necessary to get the hub to slide over. You may want to slide a smaller object than the pivot pin through the hub and shaft initially to get the hub centered easily.

B. Center the pivot pin #0447-2 in the T/R hub than apply blue Loctite to the M3x5 set screw #0053, in the end of the output shaft and tighten. NOTE: Do not over tighten, breakage of the pin could result.

C. Place a M2 washer #0001 on the pivot pin then snap the clip #0447-1 into the groove. Repeat this process for the other end of the pin.

XI. BUILDING THE TAIL BOOM

Step 1. **Installing Tube Drive**

Parts Required:

1	#0587-2	Carbon Fiber Tailboom(31.5" long)	Bag11A
1	#0809-1	Tube Drive Shaft	11A
4	#0057	M4x4 Set Screws	11B
2	#0800-2	Delrin Shaft/Bearing Adapters	11B
2	#0800-3	Torque Tube Ball Bearings	11B
2	#0800-4	Delrin Bearing Supports	11B
4	#0800-5	X-Cell O-Rings	11B
2	#0800-11	Male Universals	11B

Refer to Drawing # 11.

A. Snap (one) inner bearing adapter #0800-2 inside the ball bearing #0800-3. Support the bearing below the inner race and press the delrin adapter in place until it snaps. Place the assembly over an upright outer delrin bearing support #0800-4 (cupped end) with the adapter flange upward. Press until it also snaps in place. Repeat with the other parts. Slide (one) O-ring into the first outside groove of either end of the completed bearing assembly. Pass a second O-ring in the same manner into the second groove. Repeat this process on the remaining bearing assembly. Using a wooden dowel or similar device which will slide inside the tailboom. Press each boom bearing assemblies into the tail boom 10.5" from each end. (NOTE: A small amount of dish washing soap and water inside the boom and on the rubber O-Rings will make the assembly slide easier.)

B. Note the design of the steel insert in the graphite shaft #0809-1. The alignment of the male universal #0800-11 is dictated primarily by its fit over the exposed portion of the steel insert. When slid in place, it will automatically stop at the end of the graphite tube. As a secondary point of alignment, the large I.D. bore of the male universal will snugly fit over the O.D. of the graphite shaft. This provides additional support for the ends of the graphite tube which are the most vulnerable to damage. There may be a little fitting necessary to install the male universal. Ideally, the fit should be a light press fit(never force it in any way). If the male part will not fit in this manner, simply lightly sand the last 15.0mm of the graphite tube with a little sandpaper such as 400-600 grit, using a rotating motion between fingers. When the male universal is properly positioned, you will see the center point of each milled flat directly in the center of the set screw holes. Apply Loctite and securely tighten the M4x4 set screws #0057.
NOTE: It is not recommended to apply adhesive to any part of the male universal installation since future service will be impossible.
After one male universal is in place, insert the graphite tube into the tail boom through each bearing assembly, sliding in far enough to allow installation of the remaining universal joint. Install the other universal #0800-11 in the same way.

Step 2. **Installing Tail Rotor Push Rod Guides and Fin Mounts**

Parts Required:

1	#0585-1	Carbon Boom Support	Bag 11A
1	#0375	T/R Push Rod (700mm)	11A
1	#106-38	T/R Push Rod Extension (394mm)	11A
1	#0481	Horizontal Fin	11C
1	#0486	Vertical Fin	11C
5	#0477	T/R Control Rod Guides	11D
1	#0385	T/R Control Rod Coupler	11D
1	#0479	Horizontal Fin Mount	11D
1	#0683	Tailbox Clamp(with pre-drilled hole)	11D
		Assembled Tail Rotor Gear Box (From Section X)	
5	#0015	M2 Hex Nuts	11E
5	#0043	M2x10 Slotted Machine Screws	11E
2	#0009	M3 Small Washers	11E
2	#0019	M3 Locknuts	11E
3	#0025	M2.2x6.5 Phillips Screws	11E
5	#0032	M2.9x9.5 Phillips Screws	11E
3	#0063	M3x10 Socket Head Bolt	11E
1	#0071	M3x18 Socket Head Bolt	11E
2	#0133	Plastic Ball Links(Long)	11E

Refer to Drawing # 4, 11 and 13.

NOTE: The notched end of the tail boom is the rear (Tail Transmission) side.

A. Slide the #0479 horizontal fin clamp onto the tailboom 9-3/8" from the rear. Loosely mount the five tailrotor control rod guides #0477 by wrapping them around the boom and securing each with an M2x10 machine screw #0043 and a M2 hex nut #0015. Mount one between the horizontal fin clamp #0479 and the "rear" end of the tailboom and mount the other four in front of the horizontal fin clamp.(The screws are long enough to allow the control rod to be snapped in from the sides when needed). Measuring from the notched end of the tailboom, the first control rod guide should be 100mm from the end. The next guide should be 130 millimeters from the first one. The next 3 guides should be 145 millimeters apart.

B. Slide the Tailbox clamp #0683 onto the boom and install the M3x10 bolt #0063 and M3 locknut #0019 which squeezes the clamp together. Do not fully tighten. NOTE: Notice that the boom is notched and that the tail box has a key on one side which when inserted into the boom notch will prevent any rotation of the tailbox.

C. Slide the assembled tailrotor gear box into the boom as far as it will go, slide the clamp up against the tailbox and align the three holes. Screw the tailbox to the clamp using the three M2.9x9.5 Phillips screws #0032 and slow cyano. Ensure that the tailbox is fully seated then tighten the M3x10 bolt in the clamp.

D. There is a small hole pre-drilled in the top of the clamp #0683. Using a #55 or a (.052) drill bit, drill through the boom and the top half of the tailbox. The bit will stop when it hits the input shaft. Install one of the three M2.2x6.5 Phillips screws #0025 into this hole. This screw will act as a safety to ensure that the tailbox cannot be ejected.

E. View the drawing to verify correct orientation of the carbon tailboom support #0585-1.

Bolt this support to the horizontal fin clamp using a M3x18 socket head bolt #0071 and a M3 locknut #0019. Do not tighten.

F. If you are electing not to paint the fins you may install the horizontal fin #0481 and the vertical fin #0486 at this time. Install the two remaining M2.2x6.5 Phillips screws #0025 in the two holes in the top of the horizontal fin #0481 and into the fin mount #0479. A small amount of Goop or silicone glue under the horizontal fin #0481 will help extend the life of the fin. Use two M2.9x9.5 Phillips screws #0032 to mount the vertical fin into the tail rotor transmission mount #0683.

G. Examine the central rod coupler #0385, noting that it will accept the control rods beyond their threaded portion. The intent is to better support the rods against bending. Use the coupler to join the tail rotor control rod #0375, and the tail rotor control rod extension #106-38. (Protect the rods with tape or cloth when clamping them to allow the coupler to be screwed on.) Be sure both rods enter the coupler approximately 7mm in depth. Start a long plastic ball link #0133 on each end of the push rod. Exact adjustment will be made later.

H. Slide the tailboom into the mechanics holding the tailbox with your right hand and holding the mainshaft with your left. Spin the main shaft back and forth until the tail drive engages, then push the boom in as far as it will go. Mark the boom next to the tailboom support halves #0185 with a piece of tape or put a small scratch on it with an x-acto knife. Slide the boom back about 1.0mm. Standing behind the model, sight the tailbox to the mainshaft. Make sure that the T/R shaft is perpendicular to main shaft. Tighten the four M3x30 bolts in the tailboom support halves, then recheck alignment. **Option:** Due to the size of some workshops and the aggravation of spinning a model around on the table wondering what you are going to knock over next with the tailboom, you may want to wait until you've finished setting up the main mechanics before installing the tailboom.

I. Slide the fin clamp forward while guiding the lower boom support mount at the other end of the boom support #0585-1 between the lower mainframes. Align the support with the two holes in the mainframe then place a M3 small washer #0009 on two M3x10 bolts #0063 and thread the two bolts into the mount and tighten. Rotate the horizontal fin mount back and forth slightly to ensure that it is not pushing or pulling the boom into a bind. Align the horizontal fin perpendicular to the mainshaft and then tighten the M3x18 bolt in the horizontal fin mount #0479.

J. Install the tailrotor pushrod and attach up both ends. Align all the pushrod guides so that there is no binding throughout the travel of the pushrod. Fine adjustment will be done later.

XII. INSTALLING EXHAUST SYSTEM AND FUEL TANK

Step 1. **Fitting the Fuel Tank** and Exhaust System

Parts Required:

1	#106-52 Fuel Tank	Bag 12A
2	#0011 Washers for Fitting	In Tank
2	#0013 Hex Nuts	In Tank
1	#0397 Fuel Line	In Tank
1	#0401 Fuel Line Clunk	In Tank
1	#0403 Fuel Line Fitting	In Tank
1	#0405 Fuel Pressure Fitting	In Tank

1	#106-54 Tank Position Plate	In Tank
2	#106-58 Rubber Channels (11.5")	In Tank

Refer to Drawing # 12.

A. Install the rubber channel #106-58 around the fuel tank openings in the frame. Start at one spot and work your way around pushing the rubber channel tightly into the corners. Trim the channel so that it meets end to end while pushing the channel into the corners.

B. Slide the fuel tank through the frames "Cap first" from the right hand side of the machine. The tank should stick through the left hand side of the machine just far enough so that it gets a good hold on the frame. Clearance must be maintained for the exhaust system.

C. If you are using our Magna Pipe #3951 or muffled Nitro Pipe #3961 this tank location will work fine. Other exhaust systems may require some variation of the fuel tank position.

D. As per the drawing mark where the fuel fittings are to be installed before you remove the tank. Also note that both fittings should be on the same end of the fuel tank as it will simplify removal of the fuel tank. Also draw a line on the bottom of the fuel tank on each side between the frames. Remove the tank and use coarse sand paper to rough up the area between the lines where the positioning plate #106-54 will be glued. Also rough up one side of the tank positioning plate #106-54.

E. Use a #13 or a .185 drill bit to drill the holes for the fuel fittings. If the drill bit doesn't make a clean hole, use a sharp X-acto knife to clean up the holes.

F. Install the fuel pressure fitting #0405 from inside the tank followed by a fuel fitting washer #0011 then a hex nut #0013. Tighten the nut securely to prevent leakage.

G. Install the fuel line fitting #0403 in the tank from the inside. The threaded portion of the fitting should be on the outside on the tank. Place a washer and a hex nut on the fitting and tighten securely.

H. Cut a piece of fuel line (#0397) 110mm long. Push the fuel line up onto the fuel line clunk #0401 then using a long pair of hemostats slide the fuel line onto the fuel line fitting. Next hold the tank and rotate it and watch what the clunk does. It should rotate or flop freely about the tank and not be allowed to go all the way into a corner. This may cause it to suck up against a side while the engine is running and cause fuel starvation and possible failure.

I. Re-install tank and apply a liberal amount of Goop #0502 to the tank positioning plate and then stick it to the bottom of the fuel tank between the lines you've previously drawn. Use tape or rubber bands to hold the plate in position while drying.

J. Install the exhaust system ensuring that the header or pipe isn't touching the frame or fuel tank.

XIII. INSTALLATION OF RADIO EQUIPMENT

Step 1. **Installation of Servos**

Part Required:

4. Servos, (5 if mixture is to be used, special parts will need to be purchased. contact

Miniature Aircraft USA or your local dealer for in flight mixture control kit.), servo retainer screws, grommets and eyelets supplied with the radio.

Refer to Drawing # 2 and 13.

A. As per radio instruction install four grommets and eyelets in each servo.

B. Study drawing # 2 to ensure that you install each servo correctly.

C. When tightening down the servo screws, tighten them until snug then back the screws off about a quarter of a turn. This will allow the grommet on the servos to dampen out high frequency vibrations as they were designed to do.

Step 2. **Install the Switch for the Receiver, Gyro, Radio Receiver, and the Antenna**

Parts Required:

3 0389 Wire Lead Retainers Bag 13A

A. Provisions have been made in both of the radio-battery support frames #106-12 and 106-14 for the receiver switch and the gain box for the gyro. If you elect to use these positions. Mount the two devices at this time.

B. Mount the gyro motor assembly onto the rear gyro mounting plates using two layers of double-side servo tape to help isolate it from vibration. (Order #3869)

C. Plug all your servo leads into the receiver. Do not allow any wires to rub the corners of the graphite frames or any moving part. Three wire lead retainers are provided for holding servo and gyro wires next to M3 bolt heads. Route all wires as neatly as possible using small tie wraps to hold in place.

D. Stack the receiver on top of the gyro amplifier using servo tape or foam between them. Lay the two on top of the graphite battery tray #106-16 wrapped in foam and secure with either velcro or tie wraps loosely pulled.

E. If a whip antenna will be used, tests have proven that the best place to mount the antenna base is on the radio-battery support frames #106-12 or 106-14 sticking straight forward.

F. If you are electing to use a full length antenna, route it out of the canopy then down to the landing gear strut next to the skid and then back up to the tailboom. Again ensure that the wire doesn't rub any corners and is free from moving parts.

Step 3. **Mounting the Battery**

A. If you are running a single tail, not the dual tailrotor setup your battery might need to be placed behind the fuel tank to achieve a properly balanced model. The battery can be servo taped to the back of the fuel tank followed by two strips of velcro or tie wraps around the tank and battery for security, or a battery tray can be fabricated and positioned behind the tank.

B. If a dual tail is used the battery should be mounted under the front tray using servo tape and velcro or tie wraps.

XIV. ASSEMBLING AND INSTALLING PUSHRODS

Step 1. **Assemble and install the T/R and Collective Push-Pull Rods and Connect to Servos**

Parts Required:

4	#0015	M2 Hex Nuts	Bag 13A
4	#0103	M2x5 Threaded Balls	13A
8	#0133	Long Ball Links	13A
4	#106-36	T/R and Collective Push-Pull Rods 29mm	13A

Refer to Drawing # 13 and 15.

A. SPECIAL NOTE: If using a computer radio, clear all ATV's to 100%. Clear normal throttle and normal pitch curves so that they are symmetrical and throwing to there limits. Clear sub trims, trim memory, stunt trims, or anything that would change servo centering. Check direction of the servos.

NOTE: In the following steps, be sure to use Loctite on all steel threaded balls #0103. All measurements given for pushrods are from the inside of the ball links at the connection point with the push-rods.

B. Activate electronic tail rotor compensation (ATV) for "RIGHT" (Clockwise) rotor rotation. Check direction of tail rotor compensation and gyro. Put collective stick at the mid-position. Position a servo arm on the tail rotor servo so that it is square to the servo. Install two steel threaded ball #0103 with 2mm hex nuts in the arm at the same distance apart as the steel balls in the push-pull bellcrank #106-26 ,and adjust each rod to a length of 8mm. Install one pushrod then measure to ensure that the bellcrank is square to the servo arm, adjust as needed. Adjust the other pushrod so that it snaps on freely.

C. With the collective stick in the middle, set up the collective push-pull bellcrank in the exact same manner as the tailrotor push-pull bellcrank, Except the two #0103 threaded balls in the servo arm should be on a 15mm radius to allow full ATV travel.

D. NOTE: Both the rudder and collective servo arms will be in a neutral position at 1/2 collective stick.

Step 2. **Installing Collective Arm Rods**

Parts Required:

4	#0133	Long Ball links	13B
2	#0369	Collective Control Rods(35mm)	13B

Refer to Drawing # 13.

A. With the collective stick still in the center and the collective arm #106-84 parallel to the top of the mechanics, start a long ball link on each collective arm rod #0369 and adjust to a length of 17.5mm then snap one of the pushrods on and check that the collective arm is still square. Adjust the pushrod slightly if necessary. Adjust the other pushrod so that it snaps on freely.

Step 3. **Installing Throttle Pushrod**

Parts Required:

2	#0015	M2 Hex Nuts	13C
2	#0103	M2x5 Threaded Balls	13C
2	#0133	Long Ball Links	13C
1	#106-34	Throttle Pushrod (87mm)	13C

Refer to Drawing # 13.

A. Install one of the M2x5 threaded balls with a 2mm hex nut on the carburetor arm, use loctite. Adjust the carburetor arm so that it throws in a symmetrical arc on the upper side of the carburetor.

B. Start a long ball link on each end of the throttle pushrod #106-34.

C. With the collective stick in the middle position, mount a servo arm on the throttle servo pointing straight down. Position the carburetor at 50 percent or half throttle. Adjust the throttle pushrod so that it is the same length as the distance between the carburetor arm and the center of the servo arm. Snap the pushrod on the carburetor. Move the collective-throttle stick from high to low with the throttle trim full down moving the throttle rod with it to determine where the M2x5 threaded ball should be positioned on the servo arm.

D. Install the threaded ball, snap on the pushrod then adjust the ATV's at full and low stick to fine tune the throw.

Step 4. **Install Elevator Push-Pull and Elevator Push Rod.**

Parts Required:

2	#0015	M2 Hex Nuts	13D
2	#0103	M2x5 Threaded Balls	13D
6	#0133	Long Ball Links	13D
2	#0335	Elevator Push-Pull Rods (75mm)	13D
1	#0367	Elevator Pushrod (60mm)	13D

Refer to Drawing # 13.

A. Start a ball link on both of the elevator push-pull rod #0335 and adjust to a length of 56mm.

B. If using either a JR or Futaba radio, place a small wheel on the elevator servo and, using a ruler, position the wheel so that the two holes are in a straight line (no differential) with the servo wheel retainer screw, on 18mm diameter, and are equal distance from the elevator push-pull pivot stud #106-90. Install two steel threaded balls #0103 with 2mm hex nuts and tighten into the servo wheel (use Loctite). NOTE: Re-check radio for servo centering.

C. Snap one of the pre-adjusted elevator rods #0335. Adjust the rod so that the distance from both steel threaded balls #0103 in the elevator push-pull bellcrank #0560-6 to the center of the servo arm or wheel retainer screw is the same. Adjust the other pushrod so that it snaps on freely.

D. Start a long ball link on each end of the elevator pushrod #0367 and adjust to a length of 35mm. Snap the pushrod onto the pushpull bellcrank #0560-6 and the elevator bellcrank

#0157.

Step 5. **Install Right and Left Cyclic Pushrods**

Parts Required:

2	#0015	M2 Hex Nuts	13E
2	#0103	M2x5 Threaded Balls	13E
4	#0133	Long Ball Links	13E
2	#106-42	Right and Left Cyclic Pushrods (115mm)	13E

Refer to Drawing # 13.

A. Start a ball link on each of the right and left cyclic pushrods #106-42 and adjust to a length of 95mm.

B. With the roll section of the radio in neutral, position a servo arm on the roll servo square to the frames. Install two steel threaded balls #0103 on a 27mm diameter (13.5mm on each side) using 2mm hex nut #0015 and blue Loctite to secure. Install the pushrods from the roll servo to the bellcranks #0167 on the top main frames. With the collective in the middle adjust both pushrods so that the bellcranks #0167 are level or square to the frames. **NOTE:** The roll servo should be leaning back towards the main shaft slightly. If you look at the servo from the side, the pushrod and the servo should form a 90 degree angle.

Step 6. **Install Lower Swashplate Control Rods**

Parts Required:

6	0133	Long Ball Links	13F
3	0227	Lower Swashplate Control Rods (38mm)	13F

Refer to Drawing # 13.

A. Start a long ball link on each end of the three swashplate control rods #0227 and adjust to a length of 30mm. Snap the three rods onto the lower swashplate ring, front side of the elevator bellcrank #0157, and to the #0167 aileron bellcranks.

Step 7. **Installing Rotorhead and Flybar Control Rods**

Parts Required:

1	0091	M3x15 (12.9) Head Bolt (Previously mounted in head from section 1)	
4	0133	Long Ball Links	13G
2	0337	Flybar Control Rods (27mm)	13G

Refer to Drawing # 1 and 13.

A. Remove the special head bolt #0091 from the head, slide the head down onto the mainshaft and align the hole on the top side of the main shaft with the hole in the head block. This can be accomplished by holding the rotor head in one hand and spinning the maingear clockwise with the other. Install the special bolt and tighten.

B. At this point check to see how free the washout block slides up and down the guide pins #0297 in the bottom of the head block. If it is stiff, disengage the wash out block and

rotate it 180 degrees and try again. Determine which way is best and use pliers to tweak the pins a small amount as needed to one side or the other until the washout block slides up and down the pins with a minimum of drag.

C. Start a long ball link on each of the two flybar control rods #0337 and adjust to 10mm. Snap both control rods to the flybar control arms and washout arms.

Step 8. **Installing Hiller Control Rods**

Parts Required:

4	0133	Long Ball Links	13H
2	0335	Hiller Control Rods (75mm)	13H

Refer to Drawing # 13.

A. Start a long ball link on each end of the Hiller control rods #0335 and adjust to a length of 59mm. These rods go from the bell mixers on the blade holders to the swashplate. Snap both into position.

Step 9. **Installing Special Control Rods on the Head**

Parts Required:

4	0135	Short Ball Links	13I
2	0313	Special Control Rods (10mm)	13I

Refer to Drawing # 13.

A. Start a short ball link #0135 on each end of rod #0313 and adjust to a length of 1mm between the ball links. These rods go from the bell mixer to the delta plate on the rotor head.

XV. CANOPY PREPARATION

Step 1. **Mounting Clear Lexan Window**

Part Required:

1	#106-96	Lexan Window	Box
1	#106-98	Epoxy Glass Canopy	Box
12	#0025	M2x6.5 Phillips Self Tapping Screws	Bag 14A

NOTE: Because of current trends to apply wild paint job to canopy and fins, the window area was left in the canopy to allow people to express their creative side. However, a clear Lexan window is supplied for those who wish to be able to see in.

A. If you wish to use the Lexan window you must cut the opening in the canopy. Cut just inside the scribe line with a cutting wheel and clean up with a sanding drum, small file or sand paper.

B. Examine the Lexan window and note that there are two scribe lines around it's perimeter. The outer most line is your guide for cutting. Cut about 2mm - outside this line using sharp scissors or a dremel tool and cutting disc (USE EYE PROTECTION).

C. If you wish to screw the window in place, ten self tapping screws #0025 (M2x6.5) are provided. The location of each screw will be as follows: one centered at the nose, one centered on the top, one positioned at each of the three rounded corners, the remaining two screws (one for each side) should be mounted in between the nose and the back two lower mounted screws. Dividing these areas in half. After determining location of each of the 2.2x6.5 Phillips self tapping screws #0025, drill a hole at each location using a #56 or .046 bit. Holes should be 3mm from edge of canopy opening.

NOTE: Alternately, Miniature Aircraft USA canopy glue #0502 or epoxy can be substituted for screws. Use coarse sand paper (80 grit) to roughen the surfaces to be glued.

Position window in canopy and starting at the nose, drill a hole using the same bit. Start screw and tighten snug. Next, drill the center hole on top. Work your way along each side installing screws as you go.

NOTE: Once the canopy is painted and window is permanently installed, apply a drop of Polyzap to the screws on the inside of the canopy.

NOTE: Lexan window may be dyed or tinted using Rit dye with warm water and a little white vinegar.

D. Using drum sander at an angle, grind out hole on the bottom side of the nose between etch lines. This hole is for access to the glow plug via the extended T-handle glow plug wrench #4648. (Optional)

Step 2. **Mounting Canopy**

Parts Required:

2	#0003	3mm Large Washers	Bag 14A
2	#0063	M3x10 Cap Head Bolts	Bag 14A
3	#106-97	Rubber Grommets	Bag 14A

Refer to Drawing # 4.

A. Drill a 1/8" guide or starter hole in the marked location for the canopy mounts and grommets. Use a grinding stone or a tapered reamer to enlarge the holes to 7.5 - 8mm. It may be necessary to use a small screwdriver to help work the grommets into the canopy. Apply medium cyano to each grommet **inside** the canopy.

B. To install the canopy on the model, slide the canopy into position apply thumb pressure to the grommet on top of the canopy on the standoff, push grommet down until it seats. Hold the canopy on both sides and pull it over the lower standoffs and push grommets all the way on. Place a 3mm large washer on both M3x10 cap head bolts and screw into standoffs. NOTE: Refer to (section X) to determine whether or not cutouts are going to be made in the canopy for switch and gyro gain access.

Step 3. **Installation of Thumb Screw Plastic Caps**

Parts Required:

2	#106-95 Thumb Screw Plastic Caps	Bag 14A

Refer to Drawing # 4.

NOTE: Installation of Thumb Screw Plastic Cap for Canopy Retainer Screws: Suggestion - Use #106-60 or #106-62 stand-off and a block of wood. Thread the M3x10 bolt fully into the #106-60(or 62) stand-off and place the plastic cap upside down on a flat surface. Use a block of wood and hammer (or bench vise) to press the bolt head into the plastic cap. **NOTE:** It is a hard press, no glue is needed.

XVI. BUILDING THE ROTOR BLADES

Step 1. **Assembling Blade Mounts**

Parts Required:

2	3674-1	Pro-Wood Rotor Blades	Wrapped in Box
4	0019	M3 Locknuts	15A
4	0093	M3x15 Phillips Bolts	15A
2 pair	3674-5	Pro .60 Blade Reinforcements(Top and Bottom)	15A
4	3674-6	Carbon Fiber Inserts	15A
2	3723	Brass Blade Pivots	15A
2	3674-8	3/16 x 362mm Round Lead	15B
3	3712	Balsa Blade Caps	15B
2	3674-7	Rotorsport Blade Covering-White	In Box

Refer to Drawing # 14.

A. First identify the top and bottom plastic blade reinforcements #3674-5 marked with a "T" and "B". Thoroughly rough up the surface to be glued using either 36 - 40 grit sand paper or a sharp object.

B. Match the holes in the carbon fiber plates #3674-6 with the blade reinforcements #3674-5. Thoroughly rough up the mating surfaces on each.

C. Press into the larger of the three holes in each blade root-one #3723 brass blade pivot. Center the brass pivot in the holes.

D. Press each top and bottom plastic reinforcement onto the brass pivots on each blade. Line up the two bolt holes in each reinforcement with the two small holes in each blade. Press one #0093 Phillips head bolt threw any of the two holes in each blade. With a pencil or pin trace around the outer perimeters of each plastic reinforcement #3674-5 (Both top and bottom). Remove the bolts #0093 and plastic reinforcements #3674-5.

WARNING: Blade reinforcements must be glued using SLOW CYANO ONLY. **No other glue will work satisfactorily.** Read Section "E" entirely before proceeding.

E. Match each blade reinforcement #3674-5 with it corresponding carbon fiber insert #3674-6. (Refer to section "B"). Insert into the two small holes on each carbon fiber insert two #0093 Phillips head bolts. (NOTE: The surface which was not sanded will be on the bolt head side). On the top side of the rotor blade liberally apply slow cyano glue to the inside of the traced area for the blade mount. Press the top plastic reinforcement onto the glued area while lining-up the two bolt holes. Wipe away any excess glue. Immediately apply slow cyano to the insert area for the graphite plate. Press the matching graphite plate into position. Again wiping away any excess glue. Completely thread both of the Phillips head screws into the blade. On the bottom side of the blade repeat the above process using the bottom plastic blade reinforcement with matching carbon fiber insert. Secure by using two #0019 M3 locknuts and by clamping the blade pivot area with vise grips, table vise or a

suitable clamping device. Allow to thoroughly dry.
Repeat step "E" on matching blade.

Step 2. **Adding Lead Strips**

Refer to Drawing # 14A.

A. Sand each rotor blade with 220 or 320 grit sandpaper until very smooth. (Use of a sanding block and proper attention to thin trailing edges will ensure retention of the correct airfoil. Be certain the trailing edge remains straight during this operation.

B. Cut the lead strips #3674-8 into four lengths, the same length as the long slots along the leading edge of the blades. Cut two shorter pieces of lead for the two shorter slots. Be sure that all like lead strips remain equal in length.
NOTE: Using a sanding block, sand each lead strip on a flat surface by rolling under sanding block. If an exact gram weight is desired, the use of a gram scale will be necessary.

C. Place all the lead strips in their respective slots and weigh the blades on a gram scale or our new blade balancing system #0514. The total weight should be the same. If not, trim the lead in one of the slots until equal weight is achieved.

NOTE: If a gram scale is not available the following guide may be used:

Net blade weight (weight is written or root of blade)	+____ grams
Approximate weight of lead and wood strips installed	+_44__ grams
Approx. Blade covering installed	+_12__ grams
Approximate weight of blade mounts installed	+_15__ grams
Total Flying Weight	=____ grams

D. If less weight is desired, trim one of the lead pieces in each blade until desired weight is achieved.

E. If more weight is desired, you may also add bronze powder #3709 to the blades.

F. Starting at the outer end of the slot, apply a coat of thin cyano around the lead in the slots. Allow to sit for about 30 seconds, then apply cyano accelerator. Repeat this process until near the top. A small gap must be left as to allow room for the balsa strip #3712.

Step 3. **Initial Balance**

Refer to Drawing # 14B and 14C.

A. As an initial step in balancing, we will now establish the center of balance point. Using a BIC type pen, dowel, or tube of any type, position the blade lengthwise in front of you on a level surface. Using the pen as a fulcrum at 45 degrees to the leading edge, determine the balancing point, mark the blade accordingly, and repeat at 90 degrees to the previous line. (Hint: Gently rotate the pen right or left until the balance is established, and mark well for future reference, even after sanding). Both blades should balance within 1-2 millimeters of each other. Since they were factory matched and all material added accurately measured, you should have no difficulty. However, if there is an imbalance, the blades may be matched by two possible methods. First, determine which blade you wish to shift and in which direction. For example, if tip weight is to be added, simply rout out a small area at the tip of the blade slot and glue in a small amount of the excess lead strip as needed.

Keep in mind that any weight added to the blade being corrected, must also be added to the other blade at the **center of balance point**, thus retaining the original balance of the two blades. The optional bronze #3709 powder may also be used as a balancing aide. See #14.

B. Cut balsa strips #3712 for each slot and trim to fit (i.e. round corners). Press balsa firmly into slots and secure with cyano on all sides. Block sand the raised portion until flush with the blade surface. Coat with a film of cyano and wipe away excess.

C. At your option, seal the wood at the hub and tip areas with either instant cyano or fuel-proof paint. Lightly re-sand blades with 220 or 320 grit sandpaper once again. Carefully remove all dust using a clean towel or a tack rag, wiping several times. At clean blade is a must for proper adhesion of the blade covering material.

Step 4. **Cover Blades**

Refer to Drawing # 14 (1 thru 5).

A. With the blades now ready for cover, select a clean flat surface and after removing the backing material from a piece of blade covering #3674-7, lay it adhesive side up. Now carefully measure 10mm in from the near edge and mark each end with a ballpoint pen. Holding the blade with the hub in your left hand and the blade tip in your right hand, set the trailing edge down on the mark from the left end of the covering in a position to just clear the base of the hub when it is wrapped into position. Rock gently to adhere the covering to the trailing edge.

At this point, the 10mm section of blade covering will be visible between yourself and the blade trailing edge. Fold the blade toward yourself and apply pressure on the 10mm section of the marked covering. This will establish the bottom of the blades. Lift the blade up with covering clinging to the trailing edge and firmly smooth the short 10mm side onto the underside of the blade with a continuous slide of the finger. Continue rubbing the entire trailing edge as you rotate the blade upright. Do not allow the covering to touch the top blade surface until the trailing edge is firmly bonded with a clean, sharp fold.

Now rotate the blade further and progressively smooth the covering end to end as you go. Continue around the leading edge and back to overlap the starting edge of the covering on the bottom of the blade. Trim excess covering neatly from the blade and smooth the entire surface again. Repeat this process with the other blade. **Note:** A useful technique to allow good control of this sticky material and to prevent it from prematurely adhering to the blades in any area, weight the covering by sticking a piece of wire on what will be the final edge of the covering to be adhered, before starting. This will cause the covering to maintain a continuous roll-away from the blade surface until deliberately pressed down. Repeat entire process with the remaining blade.

Step 5. **Final Balance of Blades and Rotor Head**

Refer to Drawing # 14-6.

Equipment Required: **NOTE:** The performance potential of modern R/C helicopters is so great that the use of specialized equipment for proper assembly and set-up is fully justified by the results achieved. This is particularly true of balancing procedures for all rotating parts. Nothing so clearly distinguishes one helicopter from the rest as perfect blade tracking and freedom from vibration. This manual describes only the procedure usable without special equipment which includes balancing the fly bar on its own bearing in the pivot block,

and then suspending the head with main blades from the flybar across two straight edges, such as two rectangular blocks of wood. This procedure has been proven very effective and produces a vibration free head. The ultimate in head balance can be achieved by using a good static balancer such as the balancer #0514 sold by Miniature Aircraft USA or its equivalent. Its value lies in its ability to include main blade balance. If you have such a unit, use it following the instructions with it.

A. Support the rotor head assembly from Step 4 above vertically in the same manner. (A vice with soft jaws, etc.) that allows the fly bar to pivot freely around a horizontal position. Adjust the fly bar weight inward slightly on the paddle end that rotates downward. Continue small adjustments until the fly bar will remain level. Tighten all four weight set screws tight using Loctite.

B. Remove the rotor head from the main shaft. Mount the main rotor blades to the head using M4X35 socket head bolt #0082 and M4 lock nuts #0021, temporarily installed in section I. Position the blades straight out from the head and tighten the screws just enough to hold the blades in position.

C. Obtain two wood blocks at least 75mm (3 inches) high with parallel surfaces (2 short sections of good quality 2x4 serve very well) and two single side razor blades. Then, suspend the head and blade assembly between them supported on the fly bar. One main blade will invariably tilt downward.

Note: As described, before rotation of main blade on rotor head may result in a better balance. Cut a partial strip of the red tape provided (the degree of unbalance will give an indication of the width necessary) and apply near the end of the light opposite blade. Just stick a corner of the tape to the blade until the exact amount is determined. When exact balance is achieved (when the blade tips are equal distance from the bench top) apply the tape to the blade starting underneath, as with the regular covering.

D. Re-install the entire balanced rotor head assembly onto the main rotor shaft.

Step 6. **Adjustment of Static Tracking**

A. Screw in (2) M3x8 socket set screws #0563-2 at the base of the main rotor head block until they just contact the mainshaft. Stand your transmitter antenna (or something else to use as a measure) under the tip of the one blade and rotate the head carefully to make a comparison of the tip height of each blade. Adjust each set screw until moderate pressure exists on the main shaft and each blade tip is at the same height.

First Flight Tip

After hovering the model, land and let blades stop by themselves. Recheck tip height and readjust, if necessary. **IMPORTANT:** Always be sure that the blade pivot bolts are quite snug--offering significant resistance to the lead/lag of the blades. Also, after this procedure, it may be necessary to readjust the tracking slightly. Be necessary to re-adjust the tracking slightly.

XVII. FINAL MECHANICAL AND ELECTRONIC SET-UP

Step 1. **Setting Up the Collective Servo and the Collective Arm.**

Refer to Drawing # 13 and 15.

A. Move the collective stick slowly all the way to the top and check that the collective arm is going as far as possible without putting the elevator bellcrank #0157 in a bind where it sticks through

the mainframe and adjust ATV as necessary. NOTE: Also check the top pushrod going from the pitch servo to the push-pull bellcrank to see if the ball link is rubbing the bearing standoff on the push-pull bellcrank at full collective.

B. Move the collective stick slowly all the way to the bottom and adjust the ATV so that the collective arm goes all the way to the bottom without binding. At this point check that the ball link on the bottom pushrod is not rubbing against the bearing standoff. Trim the ball link slightly if necessary.

C. With the pushrod lengths given you should be able to use 100 to 110% ATV travel on the pitch servo.

D. With the collective stick at the top check that the swashplate is moving all the way to the top without binding. Adjust the four lower swashplate rods #0227 if necessary.

Step 2. **Final Swashplate and Fly-Bar Alignment**

Refer to Drawing # 13.

NOTE: Miniature Aircraft offers both swashplate and fly-bar alignment tool kits. Order #0510 and #0512.

A. **Swashplate:** A final check for a level swashplate may be achieved with the use of a main rotor pitch gauge (#0526) and a fly-bar lock (#0505). All transmitter stick and servo arms should be in a neutral position. Snap the fly-bar lock into the rotor head. Position the pitch gauge on one main rotor blade and set the pitch reading in the blade. Rotate the main rotor head in all four 90 degree positions. If the swashplate is truly level,the pitch reading will remain the same in all four positions. If incorrect, adjust the rods just below the swashplate until a level swashplate is achieved.

B. **Fly-Bar Paddles:** Now that the swashplate has been leveled, the fly-bar paddles may also be leveled, set your pitch gauge on 0 degrees. position on the paddle and adjust the paddles until they are level(Parallel) with the main rotor head. A straight rod such as a fly-bar may be used on the rotor head top as an aid in aligning the paddles. It is very important that the fly-bar control #0307 and the fly-bar paddles are all parallel to each other. For an excellent aid order #0510. (Fly-Bar alignment tool kit).

Step 3. Adjusting Pitch Curves

Refer to Drawing # 13.

A. Depending on which bell mixer ratio you selected when building the rotor head adjust your pitch curves for that type of flying. If you have selected an FAI type set up, you will probably want to run, depending on blade selection, 5 to 6 degrees of pitch in a hover (one half collective stick position) with about 10 degrees of pitch at full stick position and about 3 degrees of negative at low stick position. For the idle-up(s) you will want around 4.5 to 5 degrees of pitch at hover, 8.5 to 9.5 degrees at full top and 2.5 to 4 degrees of negative at low. For throttle hold, you will need about 5 degrees at hover, 11 or 12 degrees of positive at full and 4 to 5 degrees of negative at the low.

If you are setting up for hot-dogging, normal stick for hovering should be roughly the same as an FAI set-up. The same is true for the first idle up if your radio is equipped with two idle ups. You would use the first idle up for doing normal aerobatics, then the second idle up would be set up with 0 degrees of pitch at half stick, 4 degrees of negative at quarter stick, 4 degrees of positive pitch at three quarter stick and between 8.5 to 9.5 degrees of positive pitch at full and between 8.5 to 9.5 degrees of negative pitch at low. Throttle hold should be similar to the FAI set up, with the exception of maybe having a little more negative pitch at low for quick descents.

Step 4. **Adjusting Swashplate Throw.**

Refer to Drawing # 13 and 15.

A. Set the pitch gauge for 0 degrees of pitch. Move the collective stick until pitch gauge lines up with flybar. Set the pitch gauge for -6 degrees and with the main blades running parallel to the tail boom, give full right cyclic and adjust ATV so that the rotor blade has -6 degrees of cyclic pitch change. Repeat this process for the other side using +6 degrees on the pitch gauge. Repeat process for the elevator set up. This is the recommended maximum amount of swashplate travel that should be used.

Step 5. **Adjusting Rudder**

Refer to Drawing # 13 and 15.

First check servo for proper directional travel. Right tail stick command pulls the pushrod forward. Reverse if necessary. Turn on the ATS mixing function (for right hand rotation) on your transmitter. The 0 point should be at 1/2 throttle stick position. Adjust the low and high point to approximately 25% each. This will provide a good starting point for your first flight. Check for proper compensation direction by increasing the throttle stick. This should result in pulling forward like a right hand command. Re-Check that at 1/2 throttle stick the rudder servo arm has remained in neutral. With the throttle and rudder stick in their center position adjust the tail rotor control rod until the outer hole in the tail rotor bellcrank #0445 is approximately 1-2mm rearward from the back edge of the tail rotor transmission housing #0421. This should result in approximately 20mm distance between the tail rotor blades when folded together. Check both left and right tail rotor commands at low and high throttle positions for no binds. Adjust transmitter ATV's if necessary.

Step 6. **Gyro**

A. Carefully read the gyro instructions provided. Set gyro sensitivity to approximately 40-50%. Turn gyro and radio switches on and check for proper gyro/rudder direction operation. Helicopter nose pulled to the left should result in a right tail rotor command. Reverse gyro if incorrect. When using a gyro, a battery pack with 1000mah minimum is recommended. When switching gyro on and off, observe that rudder servo retains its same centering position. If needed, adjust gyro centering per gyro instructions.

Step 7. **Elevator and Aileron Dual Rates and ATV's**

Depending on the characteristics of which you desire dual rates should be set for your flying style. A starting point of about 70% on aileron and elevator work well. ATV's should be set for no binding.

XVIII. FINAL ASSEMBLY INSPECTION

A. Recheck entire machine for any loose nuts, bolts, or screws.

B. Re-check plans for proper installation.

C. Inspect radio installation. Check to see that there is no mistake in the operational direction of each servo with no binds.

D. Check all rod connections for proper installation.

E. Check all moving components on helicopter for bind free operation.

F. After completion of the final inspection, we recommend that you familiarize yourself with all stick movements, switches and functions of the radio system as it relates to your helicopter. Practice until you feel comfortably ready for your first flight. Be careful to always ensure that the batteries in your radio system are fully charged before each flying session. We recommend the use of a good battery voltage

meter to monitor the voltage level during use.

XIX. NECESSARY FLIGHT ITEMS

A. Obtain items necessary for flight use
1) Glow fuel(Nitro; about 10 - 30%)
2) Fuel pump (electric or manual)
3) Electric starter (12v)
4) Special starter extension (Part #4681 from Miniature Aircraft, USA)
5) 12v battery (preferably a gel-cell; 5.5 amp minimum)
6) 12 volt charger
7) 1.5v glow plug battery with charger
8) Extra glow plugs
9) Ample tools for field use
10) Frequency flag displaying your transmitters' frequency colors or numbers (Supplied with your radio system)
11) Power Panel (optional)

B. At the Flying Field:
1) Obey any flying field rules
2) Check the frequency board or any fliers for frequencies in use before turning on your transmitter
3) Perform a pre-first flight radio range check as per radio specifications
4) Pre-check all radio functions
5) Check for possible help from other helicopter pilots
6) Be sure not to leave radio unit on between usage

XX. STARTING AND STOPPING OF THE ENGINE

TO START: Always start the engine by using the transmitter trigger only (high throttle trim, low throttle stick). Check idle-ups and throttle hold for proper position of switches (off). Connect the glow plug battery connection selected to the engine glow plug. Connect the starter to the 12v battery and check that it operates in a counter-clockwise rotation. Hold the rotor head firmly with one hand. Engage the starter extension on the starter with the starter cone on top of the engine start shaft and rotate. When the engine starts remove the starter and glow plug battery.

TO STOP: Set the transmitter throttle stick and trimmer to its lowest setting. If it does not stop, but is running slow enough to halt the rotor blades, then do so and remove the fuel line to stall the engine. In this case, re-adjust throttle ATV until engine may be stopped by use of a transmitter trimmer. (After daily use of your model, we recommend the use of an after run oil for engine protection.)

XXI. FIRST FLIGHT ADJUSTMENTS

NOTE: After the first flight remember to check the static tracking.

A. Before flying double check direction of each control; tailrotor compensation direction and gyro direction. The first few flights should be limited to hovering only.

B. **Engine Carburetor Settings:** With the engine running, set the idle adjustments to enable the engine to maintain a rich reliable idle (trying to four cycle) at low throttle, mid to high trim. Set the high speed needle to accelerate, but slightly rich. The motor should transition smoothly from high rpm's to low rpm's during the flight of the helicopter. Short duration vertical climbs to test the top end are the safest method to get the high speed needle valve setting close.

Throttle and Pitch Curve: After the needle valves are adjusted the model can be trimmed for hover. The throttle curve should be adjusted so that the model is almost to the hover head speed just above

quarter stick. This helps the model lift off smoothly and also allows you to do slow vertical descents without the engine dropping out. The throttle curve above half stick should also be adjusted so that slow vertical ascents can be made without the engine speeding up or slowing down. Simultaneously adjust the hover pitch and hover throttle for the head speed you want to hover at, also ensure that the model is hovering at half stick. Next adjust the high and low side of the normal pitch curve until the model has the collective response you want in a hoover.

NOTE: Try to maintain original hovering recommended pitch settings. Flight trim for fine tuning once engine settings have been achieved. Fine tune low pitch settings for aerobatic maneuvers desired. Fine tune high pitch settings to match performance level of engine used.

C. Tail Rotor Trimming: Adjust tail rotor trimming as needed by moving transmitter until a stabilized tail is achieved. Re-center trimmer and adjust tail rotor control rod clevises until tail stabilizes with trimmer in neutral.

D. Tail Rotor Compensation: With the model in a trimmed stationary hover adjust the top tailrotor compensation so that the nose of the model stays straight. Starting at a height of fifteen to twenty feet, descend and watch for the nose of model to change direction or drift to one side or the other. Adjust lower tail comps to correct this. NOTE: The speed that you ascend and descend should be as slow as a FAI pilot might ascend and descend his heli while performing a top hat maneuver.

E. Swashplate Trimming: When the helicopter drifts to the left or the right, adjust aileron transmitter trimmer until stabilized. Re-center trimmer and adjust lower swashplate aileron rods until stabilized again. Repeat same process for fore and aft (elevator) control.

Gyro:

F. If you are using a dual rate gyro adjust the high rate for hovering as high as it will go without oscillation of the tail once you get the model flying in forward flight. Adjust the gyro on the low rate as high as it will go without the tailrotor oscillating.

G. Main Rotor Blade Tracking: The tracking of the main rotor blades may be checked just prior to lift-off. Be sure to maintain a safe distance from your machine. The adjustments can be made by changing the length of the Hiller Rods, #0335, on each side of the head. A piece of colored tape must be applied to one blade during balancing in order to determine which blade is high or low. Tracking procedure:
- Blade speed is low, lower the higher blade
- Blade speed is high, raise the higher blade
- If blades are out an inch or better, re-check original bench pitch settings

H. Top Pitch: Adjust the top end pitch on your idle up functions so that the model will fly at full throttle without losing head speed. A model with to much top end pitch tends to be "pitchy" and unstable.

XL-Pro Graphite Parts Replacement List

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

106-01	Machined Aluminum Bell Mixing Arm	1	13.95	L
106-02	M3x7 Flanged Bearing	1	7.95	L
106-05	Machined Washout Control Arms	1	13.95	L
106-06	Small Flanged Bearings For Wash-Out Pivot	1	7.95	L
106-07	M2x16 Pivot Pin	1	1.95	L
106-08	M2 Grip Ring	4	1.95	L
106-10	Servo Side Frame (Graphite)	1	21.95	L
106-12	Radio-Battery Support Frame "Right" (Aluminum)	1	17.95	L
106-14	Radio-Battery Support Frame "Left" (Aluminum)	1	17.95	L
106-16	Graphite Battery Tray	1	7.65	L
106-18	"Threaded" Spacer (Hex Type)	1	2.75	L
106-20	"Unthreaded" Spacer	1	1.60	L
106-22	Rubber Grommet Isolators	2	1.35	L
106-24	Dampening Sleeve	1	1.00	L
106-25	Aileron Stud Retainer Collar (gold)	1	2.75	L
106-26	Push-Pull Bellcrank with Bearing	1	6.95	L
106-27	"T" Bellcrank Bearing Spacer	1	3.30	L
106-28	Bellcrank Standoff with 3x16 Stud	1	7.65	L
106-30	Special Stepped Washer	1	1.55	L
106-32	1/8" Abs Blocks	2	1.30	L
106-33	Phillips Self Tapping Screws	10	1.95	L
106-34	Throttle Push Rod 87mm	1	1.20	L
106-36	Collective Push Pull Rod 29mm	1	1.95	L
106-38	Tailrotor Push Pull Extension 394mm	1	1.50	L
106-40	Solder End for Push Rod	1	1.95	L
106-42	Roll Servo Push Rod 115mm	1	2.30	L
106-52	Fuel Tank	1	7.95	L
106-54	Tank Positioning Plate	1	1.00	L
106-58	Rubber Channel 11.5"	1	1.55	L
106-60	Lower Canopy Standoff	1	3.65	L
106-62	Upper Canopy Standoff	1	3.50	L
106-66	Graphite Landing Gear Brace	1	4.35	L
106-68	Fan Shroud Bracket	1	2.75	L
106-70	Vertical Aluminum Frame Plate	1	20.95	L
106-72	Frame Plate Corner Blocks	1	5.50	L
106-74	Lower Mainframe Side (Graphite)	1	29.95	L
106-75	Aluminum Lower Frame Channel	1	7.95	L
106-76	"Threaded" Spacer	1	4.25	L
106-78	"Unthreaded" Spacer	1	2.95	L
106-80	Top Mainframe Side (Graphite)	1	24.95	L
106-82	Support Bracket	1	7.50	L
106-83	Collective Arm Without Bearing	1	11.95	L
106-84	Collective Arm with Bearing	1	17.50	L
106-85	Collective Arm Doubler Without Bearing	1	11.95	L
106-86	Collective Arm Doubler with Bearing	1	17.50	L
106-90	Special Pivot Stud	1	4.25	L
106-91	Elevator Swing Arm with Bearing	1	14.50	L
106-92	Collective Arm Brace	1	4.95	L
106-93	Elevator Swing Arm Without Bearings	1	9.95	L
106-94	Spacer for Pivot Stud	1	1.85	L
106-95	Thumb Screw Knobs	2	1.95	L
106-96	Lexan Window	1	14.95	L

106-97	Rubber Grommet	2	1.00	L
106-98	Canopy (XL-Pro) Epoxy Glass	1	49.95	L
106-99	Decal Sheet	1	5.95	L
106-100	XL-Pro Instruction Manual & Plans	1 set	19.95	L

We wish you good luck and many happy hours of flying!
If you have any further questions, feel free to call us.

The staff at Miniature Aircraft USA would like to express their appreciation to Wyane Mann, Tim Schoonard and Paul Bittengle for their time and dedication in the creation and final production of the X-Cell Xl-Pro Instruction Manual.

MINIATURE AIRCRAFT USA
3743 SILVER STAR ROAD
ORLANDO,FLORIDA 32808
U.S.A.

PHONE (407) 292-4267
FAX (407) 292-4296

NO.	I.D.	O.D.
0001	2.0	5.0
0562-1	M3	X4.9
0446-4	3.0	X8.0X.08
0003	3.0	9.0
0273	6.5	8.5
0009	3.0	7.0
0327	5.0	10.0
0007	6.6	12.3
0005	7.4	14.0
0213	6.2	12.9
0329	8.0	13.0x.25
0331	8.0	13.0x.50
0325	10.0	15.8

NO.	SIZE
0161	3.0x11.7
0225	2x13.7
0451	2x17.7
0297	2.5x24

NO.	SIZE
106-33	M1.75X4.0
0025	2.2X6.5
0027	2.2X9.5
0029	2.2X13
0035	2.2X14
0051	M3X3
0053	M3X5
0055	M3X6
0563-2	M3X8
0057	M4X4
0551-5	M4X4
0561-1	M5X12 Brass
0033	M3X5
0031	2.9X6.5
0089	M3X10
0093	M3X15
0095	M3X19
0097	M3X22
0099	M3X30
0080	M4X14
0081	M4X16
0083	M4X35
0085	M5X16

NO.	SIZE
0015	M2
0017	M3
0019	M3
0021	M4
0446-2	Special Nut
0563-1	M3 Insert
0041	M2X8
0043	M2X10
0045	M2X14
0047	M2X16
0552-5	M2.5X12
0061	M3X8
0063	M3X10
0065	M3X12
0067	M3X14
0069	M3X16
0091	M3X16
0071	M3X18
0073	M3X20
0075	M3X25
0077	M3X30
0079	M3X35

M1:1