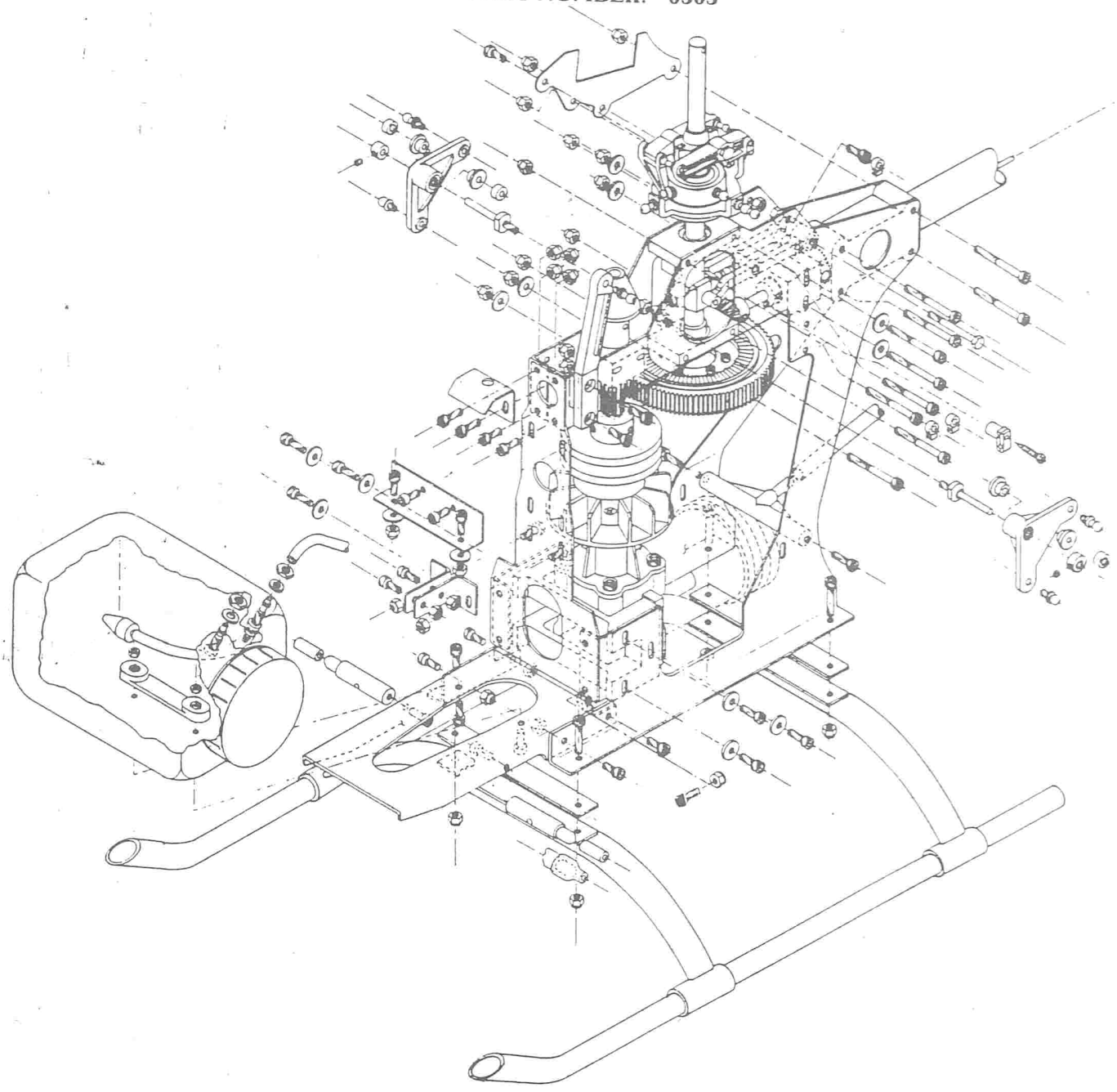
SCHOONARD Helicopters'

X-CELL

FIFTY AND SIXTY SERIES HELICOPTERS

INSTRUCTION MANUAL

PART NUMBER: 0503



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.

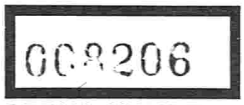
It is essential to recognize and guard against this tendency. Follow building instructions exactly. Use only original parts - even single screws - and consider no alterations. Vibration and stress levels are high and all fasteners and attachments must be secure for safety in operation.

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

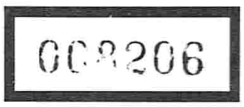
1. Fly only at approved flying fields and obey field regulations.
2. Follow frequency control procedures. Interference can be dangerous to all.
3. Know your radio. Check all transmitter functions before each flight.
4. Be aware that rotating blades are very dangerous and can cause serious injury. Always 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.



X-CELL

WARRANTY REGISTRATION

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



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 specific 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 parts 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
2324 N. Orange Blossom Trail
Orlando, FL 32804

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.

Conventional four-channel radios can be used with a fifth servo added for Collective Pitch. This servo is normally operated in parallel with the Throttle servo through a "Y" connector. Such a system is adequate but performance is limited by the lack of "mixing" functions which, in the typical helicopter radio, provide tail rotor compensation for varying throttle/collective inputs, as well as "throttle hold" for autorotation practice, "hi-idle" for aerobatics, and a multiple servo reversing feature which allows sustained inverted flight.

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 X-Cell is offered in .30(5cc), .40(6.5cc), .50 (8.5cc), and .60 (10cc) versions, a wide choice of engines is 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 - with the possible exception of Collective Pitch - 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 X-CELL 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 workplace, and get all required tools together before you begin.

THE KIT PACKAGE

The kit includes a detailed drawing showing all parts - with numbers - in proper relation to each other in easy to understand subassemblies. The drawing also includes 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.

After the plans, canopy halves, and large decal trim are removed from the kit, a cardboard tray can now be removed to disclose the rest of the parts which are either in bags containing just the parts needed for a particular assembly step, or packaged or wrapped separately.

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 wood radio tray and plastic 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
5.0mm Open End Wrench
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
Glowplug Wrench (#4649)
Scissors
Poly-Zap Pt-22 Cyano Glue (#4945)
Cyanoacrylate Glue (both thin and gap-filling)
Loctite (MA/USA) thread lock liquid (supplied in kit)
(**NOTE:** Use only the material supplied or its **EXACT** equivalent)
Wood finishing materials (sandpaper, paint, etc)
Masking tape
11mm sq x 1' Long Wood Block for Head Setup (supplied in kit)
Heat Gun (Monokote type)
Grease, Teflon Filled (Order #4709 - 2 oz tube, or #4707 - 1 oz syringe)
Tri-Flow Teflon Oil (#4801)

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

Ball Link Application Tool (#0529)
5.0mm Nut Driver (#4669)
5.5mm Nut Driver (Socket on a Handle) (#4670)
7mm Nut Driver (#4671)
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 (#0545)
Pitch Gauge (#0526)
Flybar Lock (#0505)
Tail Rotor Blade Balancer (Part #3750)
Special Canopy Glue (#0502)

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 (view #'s and figure #'s) before beginning assembly. Note that the drawing includes 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. ***Series .50 parts will be identified with an * where different from Series .60 parts.*** 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. Assemble Head Block and Yoke
2. Install Bell Mixers on Main Blade Mounts
3. Assemble and Install Main Blade Mounts
4. Assemble Flybar, Weights, Paddles and Arms
5. Fabricate Main Rotor Blades and Install
6. Balance Head Assembly

II. MAIN FRAME STRUCTURE

STEP 1. Assemble Landing Gear
2. Assemble Elevator (Pitch) Swing Arm Unit
3. Assemble Aileron (Roll) Bellcranks to Main Frames
4. Assemble Main Frames, Supports and Tray
5. Assemble Main Shaft, Gear, Swashplate, and Washout Unit
6. Assemble and Install Front Tail Drive
7. Assemble Engine and Clutch Unit
8. Complete Main Frame Structure and Mount Assembled Landing Gear

III. RADIO TRAY ASSEMBLY

STEP 1. Assemble Plastic Tray
2. Fit Servos

IV. TAIL ASSEMBLY

STEP 1. Assemble Tail Rotor Transmission and Collective
2. Assemble Tail Boom, Drive Shaft, and Fins
3. Install Tail Rotor Transmission

V. RADIO TRAY AND TANK INSTALLATION

STEP 1. Mount Fuel Tank
2. Install Radio, Gyro, and Switches

VI. ROTOR HEAD AND TAIL ASSEMBLY INSTALLATION

STEP 1. Mount Rotor Head
2. Mount Tail Boom and Engage Drive
3. Mount Tail Rotor Control Rod and Guides

VII. CANOPY PREPARATION

STEP 1. Assemble Canopy and Paint

VIII. FINAL ASSEMBLY AND SET UP

STEP 1. Set Servo Neutrals at Transmitter
2. Mount Servo Control Arms (or Wheels)
3. Install Control Rods
4. Final Assembly and Balance
5. Control Set Up

I. ROTOR HEAD ASSEMBLY

Step 1. Assemble Head Block and Yoke

Parts Required:

1	#0289 Main Rotor Head Block	Bag #1
2	#0292 Flybar Yoke Halves	Bag #1
1	#0294 Pivot Block (Long Type)	Bag #1
2	#0301 M3x10 Ball Bearings	Bag #1
2	#0299 M4x10 Ball Bearings	Bag #1
2	#0297 Guide Pins (M2.5x24)	Bag #1
2	#0109 M3x8 Threaded Balls	Bag #1
2	#0033 M3x5 Phillips Crossed Recessed Screws	Bag #1
2	#0296 Plastic Spacers (M3.2x6x3)	Bag #1
2	#0298 Black Delrin Bearing Cups	Bag #1
4	#0063 M3x10 Socket Head Bolts	Bag #1
2	#0339 Delta Offset Plates	Bag #1

Special Tools Required: Small wooden dowel or similar device with an O.D. that fits through the .236 (6.0mm) I.D. hole in #0294 pivot block. This device should have a minimum length of about 2". HINT: The #0267 start/clutch will work.

A. Examine **View #1** showing the head block and flybar yoke/hi-tilt assembly. Lay out the #0289 head block, the #0294 pivot block, both #0292 flybar yoke halves, two #0296 plastic spacers, and two #0301 ball bearings. Apply a small amount of Loctite (regular or permanent type) to the areas of shaft nearest the center hub on each side of the pivot block. Slide a ball bearing on each end and seat each fully (if necessary, tap into place, applying force only to the inner race).

Identify the two small holes recessed at the ends of the middle bore in the #0289 head block, and squarely thread an M3x5 phillips cross recessed screw 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. Now thread the other M3x5 phillips screw into the remaining hole until it seats and traps the pivot block. Neither screw should be so tight as to bind the bearings; rather, they should be adjusted equally so that neither end play nor bearing bind exists. Rotate the pivot block until its cross hole is squarely visible through the side slots in the head block (it may be held level in this position using the special tool described earlier.) Slide one #0296 plastic spacer onto each end of the exposed shafts from the pivot block. While holding the pivot block cross hole level within the head block, 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. It is satisfactory to be reasonably level with all three components discussed above.

B. Examine each #0298 Delrin bearing cup. Note that one side is made to accept an M4x10 bearing with a snap fit. Proceed to snap one #0299 bearing into each bearing cup, making sure that it is fully snapped in place. 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 own convenience, temporarily apply a small piece of tape on each side of the rotor head block and designate one side as left side and one as 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 (axle through hole perpendicular to your line of sight), position one delta offset plate up against one end of each flybar yoke half (aligning each unthreaded through hole in the plate with each flybar yoke half hole) with the M3 threaded hole offset to your right. Install (2) M3x10 socket head bolts with a small amount of cyano through each delta offset plate and into each flybar yoke half. Be sure that the bearing cup faces outward. Rotate the head 180° and repeat the process. When finished, you will find each delta offset plate opposite in position with the other. 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 #0109 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 is an unfortunate drawback to the desired geometry of the offset ball mixer layout and will not cause any problem. Be sure each #0109 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 sand paper and epoxy or slow cyano applied. Also, it may be necessary to "tweak" them somewhat later to allow the washout hub #0210 to smoothly travel up to its limit under the head without drag.

Step 2. Install Bell Mixers

Parts Required:

2 #0333 Bell Mixers	Bag #1
4 #0159 Ball Bearings for Bell Mixer (M3x7)	Bag #1
2 #0093 Special Bell Mixer Screws (M3x18)	Bag #1
2 #0115 M3x10.5mm Threaded Balls	Bag #1
2 #0109 M3x8 Threaded Balls	Bag #1
2 #0017 M3 Nuts	Bag #1
2 #0317 Main Blade Mounts	Bag #1

NOTE: This is the first step involving the threading of control link balls into plastic parts and three important requirements **must** be met. First, the ball thread must be started squarely in the hole. This is assured by first pushing the ball onto the allen wrench (a quality feature of this kit is the series of custom control balls used that have hex sockets in the end), and carefully starting the threaded end into the hole as squarely as possible. This can be determined by alternately viewing the ball and wrench from two aspects 90° apart ("backing up" the thread a small amount before turning in the normal direction will help prepare the plastic hole to accept the screw thread). Second, a small amount of slow cyano acrylate glue must be applied to the thread. Normally this can be done to the remaining threads after the part has been threaded halfway on. Be careful not to get glue on the ball or your fingers -- use a toothpick. Third, the ball must not be threaded in so tightly that the threads created in the plastic are stripped. Each ball has a flange intended to seat against the plastic part, so thread the ball down until this flange just contacts the surface. **See View #1.**

A. Thread a long shank and a short shank threaded ball into each #0333 bell mixer. Use slow cyano and be sure to thread in squarely without over-tightening.

B. Using a #0093 bell mixer screw to assist in alignment, press a #0159 ball bearing into each side of each #0333 bell mixer. Be sure the bearings are square and properly seated.

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.

With the stepped side facing away from the head of #0093, slide each bell mixer assembly on a #0093 bell mixer screw and thread into the hole nearest the main body of each #0317 blade mount. Using Loctite, thread a #0017 M3 nut on the exposed threads of #0093 screw on the inside of the blade mount arm. Tighten the nut securely against the inside of the control arm. Do not be alarmed if the nut takes on a slanted appearance after light tightening -- its function is solely as **extra** security and is not at all critical (should you wish, the nut may be completely eliminated by putting a small amount of slow cyano or epoxy over the exposed threads - it is your option). Apply slow cyano to the nut against the plastic, as a fillet. Be sure each bell mixer is adjusted to allow for no drag or free play. **See View #1.**

Step 3. Assemble and Install Main Blade Mounts

Parts Required:

1 #0315 Main Blade Axle	Bag #1

2	#0317 Main Blade Mounts	Step 2 Assembly
4	#0319 Ball Bearings, Main Blade Axle (M8x16)	Bag #1
2	#0321 Main Axle Thrust Bearings	Bag #1
2	#0323 Dampner O-Rings	Bag #1
2	#0325 Thrust Bearing Washer Spacers (M10x1)	Bag #1
2	#0327 Bearing Retainer Washers (M5x2)	Bag #1
2	#0329 Thin Shim Washers (M13x.25)	Bag #1
2	#0085 M5x16 Socket Head Bolts	Bag #1

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

A. 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 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. Treat the remaining blade mount in a similar manner. Remove the axle.

B. Referring to **View #1**, carefully slide a #0323 dampner 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.

C. Select the two #0329 shim washers (the thin ones) and slide one on each end of the blade axle. Slide a blade mount on one end of the axle. Refer to **View #1** for proper orientation.

NOTE: Optional #0331 thick shim washers may be used **instead** of (and not in addition to) the standard #0329 thin washers to stiffen dampening. This stiffer set-up would only be beneficial if one of the following situations existed:

1) Sitar, Pica, Vario or L.M. Glass blades are substituted. Due to their construction, they are too flexible for soft head dampening. Miniature Aircraft USA Rotorsport Pro Kevlar blades are especially constructed to be very stiff so they work well with the standard #0329 thin shim washers.
2) Blades of considerable extra length are utilized. This in **only** possible when other modifications or fuselage length allows their use with proper clearance.

D. 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 (groove down). Set aside until you reach Step F.

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

F. 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).

G. Repeat Steps D, E, and F 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 orientated 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.

Step 4. Add Flybar, Paddles, and Control Arms

Parts Required:

1	#0303 Flybar	Bag #10 (inside tailboom)
2	#0311 Control Paddles	Bag #1
2	#0309 Flybar Weights	Bag #1
2	#0307 Flybar Control Arms	Bag #1
2	#0305 Control Arm Spacers	Bag #1

4	#0051 M3x3 Socket Set Screws	Bag #1
2	#0053 M3x5 Socket Set Screws	Bag #1
4	#0135 Plastic Ball Links (short)	Bag #1
2	#0313 M2x12 Short Control Rods	Bag #1

A. Thread the M3x3 socket set screws partly into the two tapped holes in each of the two #0309 flybar weights. Similarly, thread an M3x5 socket set screw in the threaded hole in each #0307 flybar control arm.

B. Insert the flybar #0303 into the bearings provided in the main head assembly. Follow with one #0305 spacer and one #0307 control arm on each side. Slide each up to the delta offset plates and 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 to 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.

C. Slide one #0309 flybar weight onto one end of the flybar. Mark with tape or pen a point 25.0mm (about 1") from the end of the flybar. Apply a small amount of slow cyano or epoxy on the flybar threads and install one #0311 control paddle to the 25.0mm depth. Visually align it level with its corresponding control arm. A pitch gauge set at zero is most helpful for this step (you may consider the Miniature Aircraft USA precision pitch gauge #0526 for this and future set-up steps) when used with a simple straight edge held on the control arm. Repeat these steps on the opposite end of the flybar. A template is shown in **Figure #1** that can also assist you in paddle alignment.

When both control paddles and their respective control arms are all level to each other, determine the approximate position of each flybar weight and fine tune their positions for balance. If you are a beginner or sport flier, you will find the weights work best at or near each paddle. if you prefer the quick response required for hot aerobatics, then position the weights inward towards the control arms. Basically the model is still fully aerobatic in either set-up, but the response time will change.

D. Assemble two short #0135 ball links on each #0313 control rod. Start a ball link on each end of the fully threaded rods and thread on simultaneously until the links come together. Back off one half turn. Match for exact length and install each between the **long** shank ball on a bell mixer and the threaded ball on the delta offset plates. Each will appear nearly vertical when installed and will be opposite diagonally across the rotor head (as viewed from above) from the other.

Step 5. Fabricate Main Rotor Blades

Parts Required:

4	#0034 Phillips Countersunk Head Tapping Screws (M2.9x13)		Bag #1
2	#3710 Lead Strips		Bottom of Box
2	#3712 Balsa Strips		Bottom of Box
2	#3721 Blade Mount Reinforcements (2 pr)		Bag #1
2	#3651 Main Rotor Blades (X-60)		Box
2	#3653 Main Rotor Blades (X-50)	*	Box
1	#3701 RotorSport Covering Pkg.		Box
1	#3711 Trim (balancing) Strip		Decal Sheet
2	#3723 Brass Blade Bushing		Bag #1

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. Lay all four blade reinforcement halves on a table with insides facing up. Match male and female reinforcement halves together. Using **slow cyano only**, choose the male reinforcement half and apply even amounts of slow cyano to inner surface of reinforcement and line up with rotor blade root. Push reinforcement on to blade root until it is completely snapped down. It may be necessary to use a rubber hammer for this step. Take care not to damage rotor blade. Immediately apply cyano to matching female reinforcement half and assemble on blade in the same manner as the first half. Press the brass bushing #3723 completely into blade mount pivot hole. Insert 2 #0034 M2.9x13 Phillips Countersunk Head Tapping Screws into remaining two holes in blade mount reinforcements. Tighten securely. Next apply pressure to the reinforcement halves by either clamping together or using a heavy object as a weight on top of the blade reinforcement. Tighten securely. Set aside and allow to dry and repeat process on second blade. **See Figure #2A and View #1.**

C. Cut the lead strips #3710 equal in length to the slots provided in the main rotor blades and equal length to each other. **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. For an approximate weight, the following guide may

be used:

Net blade weight written on root of blade	+ _____	Grams
Full length of Lead Strip w/ Balsa Caps (3 pcs)	+ 21	Grams
Blade Covering	+ 14	Grams
Approximate Blade Weight	= _____	Grams

If less weight is desired, shorten the lead strips and mount them towards the outside of the milled slots. It is very important that while adding the lead to the rotor blades that the overall weight of the rotor blades remain relatively equal to each other. This can be achieved by a gram scale; if one is not available, then we have an alternative method which works very well.

Mount the unfinished rotor blades into the previously assembled main rotor head using Allen Bolts #0082 and Locknuts #0021. Tighten snugly. Pivot the rotor blades until both blades are centered and in line with the main rotor blade mounts #0317 and parallel to each other. Suspend the rotor head and blades in a balancing device as described in Step 6. **See Figure #3.** If the rotor blades do not appear to balance very well, remove the blades and replace on opposite ends of the main rotor head. Recheck balance and choose the better of the two blade positions.

Insert pre-cut lead strips into the milled slots in each rotor blade and observe balance. If balance needs correcting, cut down the lead strip in the heavier blade or add weight to the lighter blade. Adjust until balance is achieved.

D. Starting at the outer end of the slot, apply a coat of slow cyano around the lead in the slot. In a few moments follow with a layer of baking soda and saturate with cyano. **See Figure #2B.** If you've chosen epoxy for this step, simply apply epoxy to the slot and install the lead. Smooth excess epoxy with your finger. Keep in mind that a balsa strip will be used as a cap for the slot so allow a small gap. Recheck the balance one more time, and remove blades from Rotor Head. Mark which side of head each individual Rotor Blade was attached.

E. At this point you should have lead strips installed and cyano or epoxy cured. 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 flat-level surface. Using the pen as a fulcrum at 45° to the leading edge, determine the balance point, mark the blade accordingly, and repeat at 90° to the previous line. **See Figure #2C.** (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 1-2mm of each other. Since they were factory matched in this manner and all materials added were 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 what direction. For example, if tip weight is to be added, first try saturating the tip area (3"-4") with thin cyano glue. If more weight is needed, then simply route out a small area at the tip of the milled 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.

An optional brass powder may also be used as a balancing aid and as an option to increase the weight of the rotor blade. Order #3709.

F. Cut balsa strips 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 blade surface. Coat with a film of cyano and wipe away excess. **See Figure #2D.**

G. At your option, seal the wood at the hub and tip areas with either instant cyano or fuel proof paint. In either case, mask the mounting faces of the Blade Hub since they are molded for a precise fit in the Blade Mounts. Lightly re-sand blades with 220 or 320 grit sand paper once again. (Carefully remove all dust using a clean towel, wiping several times. A clean blade is a must for proper adhesion of the blade covering material.)

H. With the blades now ready for cover, select a clean flat surface and, after removing the backing material from a piece of blade covering, lay it adhesive side up.

Carefully examine the accompanying **Figure #2E** before proceeding. Now, carefully measure 10mm in from the NEAR edge and mark each end with a ball point pen. Holding the blade with Hub in your left hand and the blade tip in your right, set the trailing edge down on the marks with 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 down towards yourself and apply pressure onto the 10mm section of the marked covering. This will establish the bottom of the blade. 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 tip of the blade and smooth the entire surface again. Repeat this process with the other blade. **See Figure #2E.**

NOTE: A useful technique to allow good control of this sticky material and prevent it from prematurely adhering to the blade in any area is to weight the covering by sticking a piece of wire to 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. **See Figure #2E.**

Step 6. Balance Head Assembly

Parts Required:

2 #0082 M4x35 Socket Head Cap Screws	Bag #1
2 #0021 M4 Locknuts	Bag #1

Equipment Required: **NOTE:** The performance potential of modern R/C Helicopters is so great that the use of specialized equipment for proper assembly and setup is fully justified by the results achieved. This is particularly true of balance 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 useable without special equipment which includes balancing the Flybar on its own bearings 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 the use of a good static balancer such as the High Point Balancer (sold by MA/USA) or its equivalent. Its value lies in its ability to include Main Blade balance. If such a unit is available, use it following the instructions with it.

A. Support the Rotor Head Assembly from Step 4 above vertically in some manner (a vise with soft jaws, etc) that allows the Flybar to pivot freely around a horizontal position. Adjust the Flybar Weight inward slightly on the paddle end that rotates downward. Continue small adjustments until the Flybar will remain level. Tighten all **FOUR** weight set screws **TIGHT**, using Loctite.

B. Mount the Main Rotor Blades to the Head using M4x35 Socket Head Screws and M4 Locknuts. Position the blades straight out from the Head and tighten the screws just enough to hold blade in position.

C. Obtain two wood blocks at least 75mm (3") high with parallel surfaces (two short sections of a good quality "two by four" serve very well) and two single side razor blades. Then suspend the Head and Blade assembly between them, supported on the Flybar. Refer to **Figure #3**. One Main Blade will invariably tilt downward. **NOTE:** As described before, rotation of main blades 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 equidistant from the bench top), apply the tape to the blade starting underneath, as with the regular covering.

Identify the Blade Mount carrying the red taped blade with a small drill spot or a touch of paint, remove both blades and set both the head and the blades aside until Step V-1.

II. MAIN FRAME STRUCTURE

Step 1. Assemble Landing Gear

Parts Required:

2 #0151 Flexible Struts	Box
2 #0153 Skids	Bag #10 (Wrapped)

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

A. Examine **View #2** on the drawing to determine assembly orientation of the Struts and Skids. Note that 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 227mm.

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

62mm. Again check drawing for orientation. The distance between the bolt holes from the front to the rear strut should be 165mm.

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. Set this subassembly aside.

Step 2. Assemble Elevator (Fore and Aft Pitch) Swing Arm Unit

Parts Required:

2	#0155 Elevator Swing Arm Halves	Bag #2
1	#0099 Special Bolt (M3x30)	Bag #2
2	#0131 Plastic Bearing Bushings	Bag #2
1	#0157 Elevator Bellcrank	Bag #2
1	#0107 M3x6 Thread Ball	Bag #2
2	#0113 M3x10.5 Double Thd Balls (Long Threads)	Bag #2
2	#0159 Bellcrank Ball Bearings (X-60) (M3x7)	Bag #2
2	#0131 Plastic Bearing Bushings (X-50) *	Bag #2
2	#0161 Pivot Pins - Elevator (M3x12)	Bag #2
1	#0019 M3 Locknut	Bag #2
2	#0047 M2x16 Sltd HD Machine Screws	Bag #2
2	#0015 M2 Hexnut	Bag #2

A. Study **View #2** on the drawing to understand how this Swing Arm subassembly is built up.

B. Pick up one Swing Arm Half, #0155, and holding it so that the outside surface of the fork end is against a solid surface, press a Pivot Pin, #0161, into the fork end hole from the inside until its end is flush with the outside surface (bottoms against the supporting surface). Tapping the Pin into place with a mallet or wood block may be necessary. Repeat the process with the other Swing Arm Half.

C. Press a Plastic Bearing Bushing #0131 into the hole at the opposite end of each Swing Arm Half. Do this from the outside. Set both pieces aside.

D. Select the Elevator Bellcrank #0157 from the parts bag, and the Threaded Ball #0107 (single Ball end) from the parts bag. Using the proper size Allen Wrench from the tool bag and following the procedure previously described, glue and screw the ball into the arm of the Bellcrank. Refer to **View #2** on the drawing.

E. Following the above procedure, screw in place and glue the two Double End Balls #0113, again referring to the drawing for position.

F. Select either the Bellcrank Ball Bearings #0159 (X-Cell .60) or plastic Bearing Bushings #0131 (X-Cell .50) and press them into the remaining holes in the Bellcrank.

G. Referring to **View #2** again, assemble the Swing Arm to the Bellcrank by squarely pushing the Pivot Pins into the Bellcrank Bearings or Bushings, aligning and pressing the Arm Halves together. Push the Special Bolt #0099 through the Pivot Stud Bushings as a further alignment aid, loosely thread its M3 locknut on it, and secure the halves together with the two M2x16 bolts #0047 and nuts, using Loctite. Set the subassembly aside.

Step 3. Assemble Aileron (Roll) Bellcranks to Main Frames

Parts Required:

1	#0163 Main Frame, Right	Box
1	#0165 Main Frame, Left	Box
2	#0167 Aileron Bellcranks (Roll)	Bag #2
2	#0169 Aileron Bellcrank Studs (Roll)	Bag #2
4	#0159 Bellcrank Ball Bearings (X-60)	Bag #2
4	#0131 Plastic Bearing Bushings (X-50) *	Bag #2
2	#0171 Aileron Stud Retainer Collars	Bag #2
2	#0105 (M3x4.5) Threaded Balls	Bag #2
2	#0107 (M3x6) Threaded Balls	Bag #2
2	#0051 M3x3 Socket Set Screws	Bag #2
2	#0019 M3 Locknuts	Bag #2

Special Tool Required: Hand Drill (for use as collet to hold parts)
NOTE: If using an electric drill, do NOT plug in!

A. Study **View #2** on the drawing to determine proper holes for Roll Bellcrank mounting in Frames. Mark if necessary.

B. Select a Bellcrank Stud #0169 from the bag and the Left Main Frame #0165 from the box. Open the chuck on your Hand Drill until it will accept the UNthreaded end of the Bellcrank Stud, inset the Stud up to its shoulder and tighten the chuck moderately. **NOTE:** This method of holding the Studs for mounting in place protects the Stud bearing surface better than others. Later, Ball Bearings or Bushings will slide easily in place. Holding the drill chuck in your hand, insert the Stud in the proper hole in the Frame from the outside, and screw an M3 Locknut tightly onto the Stud from the inside of the Frame.

C. In a similar manner, mount the other Bellcrank Stud to the Right Main Frame #0163. Check Stud surfaces that had been held in the drill chuck for smoothness and freedom from burrs.

D. Remove a roll bellcrank #0167 from Bag #2, a Threaded Ball #0107 and a Threaded Ball #0105 from the parts bag and, holding the bellcrank with its flat side towards you, screw a Ball into each end hole, using the technique described previously (don't forget to cyano glue). Pick up the other bellcrank and, holding it oriented exactly as you did the first one, screw the shorter of the two remaining balls into the end hole AWAY from the short ball end on the first Bellcrank. Screw the remaining ball in place in the remaining hole. This provides right and left bellcranks as will become apparent upon installation.

E. Take the four Ball Bearings #0159 from the parts bag (four Bushings #0131 for X-Cell 50) and press them squarely into each end of the remaining holes in the two Bellcranks. See **View #2.**

F. Partially thread the M3x3 Socket Set Screws into the two Retaining Collars #0171.

G. Hold the LEFT Main Frame upright 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 the other arm pointing aft (to your right) containing a long ball. Place a SMALL amount of Loctite on the set screw threads projecting from one Retainer Collar and, after ensuring that NO Loctite can possibly get to a ball bearing or bushing, 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.

H. Mount the other Bellcrank and Collar to the Right Main Frame in an identical way. Holding the frames together in normal orientation will show that each has a Bellcrank that can be held with an arm pointing rearward with a long ball on it.

Step 4. Assemble Main Frames, Supports, Tray to Landing Gear

Parts Required:

Landing Gear Assembly	From Step 1
Pitch Swing Arm Assembly	From Step 2
Main Frame Assemblies	From Step 3
1 #0175 Front Frame Support Plate	Bag #3
2 #0177 Main Frame Strut Plates	Bag #3
1 #0179 Canopy Latch Plate	Bag #3
1 #0182 Main Shaft Bearing Block, Lower	Bag #3
2 #0185 Front Tail Boom Support Halves	Bag #3
1 #0187 Front Tail Boom strut Support	Bag #3
1 #0189 Tank Support Tray	Bag #3
1 #0191 Motor Mount (X-60)	Bag #6
1 #0193 Motor Mount (X-50) *	Bag #6
1 #0198 Start Shaft Bearing Block	Bag #3
8 #0077 M3x30 Socket Hd Cap Screws	Bag #3
4 #0071 M3x18 Socket Hd Cap Screws	Bag #3
2 #0065 M3x12 Socket Hd Cap Screws	Bag #3
18 #0063 M3x10 Socket Hd Cap Screws	Bag #3
24 #0019 M3 Locknuts	Bag #3
10 #0003 M3 Flat Washers (Large)	Bag #3
1 #0195 Motor Mount (OS.50) (SPECIAL ORDER ONLY)	

A. **View #2** on the drawing shows the relative parts placement and fasteners used in building up this basic frame structure. All parts should be fastened loosely until late in the sequence so that a final "squaring" and alignment can be properly done.

B. Mount the front support plate #0175 to both main frames using (6) M3x10, (2) M3X12 socket head cap screws and (8) M3 locknuts. Use the M3x12 screws to also mount the canopy latch plate #0179 against the upper front face of the front support plate. Do not tighten nuts.

C. Remove the Pivot Stud and locknut temporarily assembled to the Elevator Swing Arm and insert the Arm assembly into position between the Frames making sure that the Bellcrank arm projects through the aperture in the right side frame with the ball end UP. Reassemble the Pivot Stud through the correct frame holes to properly constrain the Swing Arm Assembly **(See View #2)**, and replace the locknut. Do not tighten.

D. Using two M3x30 Socket Head Cap Screws and M3 Locknuts, mount the Lower Main Shaft Bearing Block #0182 in position with the bearing facing up. Do not tighten nuts.

E. Using four M3x30 Socket Head Cap Screws and M3 Locknuts, loosely mount the two Front Tail Boom Support Halves #0185 in position.

F. Using two M3x10 Socket Head Cap Screws, mount the Front Tail Boom Strut Support #0187 between the Frames at the holes to the rear of the slotted holes provided for Fan Housing rear mounting. **See View #2.** The screws thread directly into the ends of the Support. Do not tighten.

G. Mount the Tank Support Tray #1089 in position under the Front Support Plate, using four M3x10 Socket Head Cap Screws and M3 Locknuts. Do not tighten.

H. Referring to drawing **View #2,** mount the Start Shaft Bearing Block #0198 in position, using two M3x30 Screws and M3 Locknuts with M3 Flat Washers under the screw heads and the nuts. Do not tighten.

I. Select the Motor Mount #0191 or #0193 (S-60 or X-50) from the parts tray and mount in position, using six M3x10 Socket Head Screws with an M3 Flat Washer under each head. Do not tighten.

J. Place the Frame assembly, as completed to this point, on a flat surface and, ensuring that both frame bottom flanges rest solidly on the surface, generally "square up" the entire unit and snugly tighten all screws and nuts except those retaining the Tail Boom Support, the Swing Arm, and the Front Tail Boom Strut Support. Check to see that the Swing Arm assembly pivots freely within the rectangular frame holes. **NOTE:** The Motor Mount and Start Shaft Bearing Block will be removed and reassembled at a later step but are needed here to help provide frame alignment.

K. NOTE: Many of the common .61 size motors cannot be installed in the frame assembly with the landing gear assembly installed. If you do not wish to remove the landing gear assembly, install (Step K) after installation of motor unit (Step 7). Place the Landing Gear assembly on a flat surface, locate the two Main Frame Strut Plates #0177 on the Flexible Struts over their mounting holes and, using four M3x18 Socket Head Cap Screws, mount the completed Frame assembly to the Landing Gear. The most convenient procedure is to insert two screws through the holes in the front gear Strut. At this point it may be necessary to reheat the rear Strut with the heat gun and slightly reposition it to line up with the Frame and Strut Plate holes. Anchor its M3x18 Screws with M3 locknuts and tighten all around.

L. At this point refer to the drawing exploded views again to ensure proper placement and orientation of all parts.

Step 5. Assemble Main Shaft, Gear, Swashplate, and Washout

Parts Required:

1	#0203 Main Shaft **OR** #0614 Long Main Shaft	Bag #4
2	#0205 Main Shaft Retainer Collars	Bag #4
1	#0182 Main Shaft Bearing Block, Upper	Bag #4
1	#0207 Main Gear	Bag #4
1	#0209 Autorotation Hub	Bag #4
1	#0211 Upper Hub Spacer (Plastic)	Bag #4
1	#0213 Lower Hub Washer (Steel)	Bag #4
1	#0215 Retainer Collar (Autorotation)	Bag #4
1	#0217 Swashplate	Bag #4
1	#0219 Center Hub, Washout	Bag #4
2	#0221 Washout Control Arms	Bag #4
2	#0223 Special Links, Washout	Bag #4
2	#0225 Pivot Pins, Washout Arms	Bag #4
1	#0111 M3x10.5 Thd Double Ball (Short Threads)	Bag #4
3	#0107 M3x6 Thd Balls	Bag #4
4	#0109 M3x8 Thd Balls	Bag #4

2	#0097 Special Bolts, Washout Arms (M3x22)		Bag #4
4	#0159 Ball Bearings, Washout Arm (X-60)		Bag #4
4	#0131 Plastic Bearing Bushings (X-50)	*	Bag #4
4	#0227 Ctrl Rods, Lower Swashplate (M2x42)		Bag #4
8	#0133 Plastic Ball Links Long		Bag #4
2	#0077 M3x30 Socket Hd Cap Screws		Bag #4
6	#0069 M3x16 Socket Hd Cap Screws		Bag #4
10	#0051 M3x3 Socket Set Screws		Bag #4
8	#0019 M3 Locknuts		Bag #4

NOTE: One of two main shaft types may exist in your custom kit. They are easily identified by their overall length: #0203 Original Type -- 182.0mm; #0614 Extended Type -- 192.0mm. If you have #0203, then it is suggested that you follow all pertinent instructions as written. If #0614 has been provided with your kit, you have a few options available. You can elect to utilize its entire length (effectively raising the rotor system 10.0mm for additional collective or cyclic travel in conjunction with the main shaft thrust bearing assembly, or you may use 5.0mm less by placing a special plastic 5.0mm spacer #0210 under the autorotation hub above the #0213 washer and #0215 collar. Similarly, two #0210 spacers may be used, effectively bringing the useable shaft length down to that of main shaft #0203. Of course, this is not the intent of shaft #0614. In most types of pitch set-ups, the added length of #0614 is an asset, not a detriment. You are encouraged to use #0614 in its full length. Further in the instructions, suitable pushrod adjustment lengths will be given, corresponding to whichever shaft length is utilized.

#0210 spacers are available from your dealer or Miniature Aircraft USA directly. If two #0210 spacers are ever used, it will be necessary to make a 22.0mm diameter hole for clearance in the fan shroud. Again, it suggested to use #0614 in its full length rather utilize two spacers.

A. Referring to **View #3** on the drawing, select the Main Gear #0207 and the Autorotation Hub #0209 from Bag #4, six M3x16 Socket Head Cap Screws, and six M3 Locknuts from the parts bag. Noting that the Gear is two-sided and can be assembled either way, press the Gear onto the shorter boss of the Hub, being careful to align the mounting bolt holes. Insert the six M3x16 Screws from the Gear side and secure from the Hub side with the six M3 Locknuts. Tighten securely. Lightly oil (**DO NOT GREASE**) the autorotation bearings.

B. Mount the Upper Main Shaft Bearing Block #0182 in place, bearing side down, using two M3x30 Socket Head Cap Screws and M3 Locknuts. Do not tighten.

C. Lay out both Shaft Retainer Collars #0205 and lower Retainer Collar #0215 and partially thread two M3x3 Socket Set Screws in each.

D. Determine the Main Shaft assembly sequence from **View #3** and lay out the following parts:

Main Shaft #0203 **OR** Long Main Shaft #0614
Two Retainer Collars #0205
Upper Plastic Hub Spacer #0211
Main Gear and Hub Assembly
Lower Steel Hub Washer #0213
Lower Retainer Collar #0215

Insert the Main Shaft into the upper Bearing Block (stepped down end first); then, in sequence, slide it through a Retainer Collar, the center hole of the Elevator Bellcrank, another Retainer Collar, the lower Bearing Block, the Upper Plastic Hub Spacer, the Main Gear (large hub **DOWN**), the lower Steel Hub Washer, and then slide its stepped down end fully into the remaining Retainer Collar. Tighten the screws in this collar and in the collar just above the Lower Bearing Block to retain the stack.

E. Rotate the Main Shaft (it will be freer one way) to ensure that the main bearings are aligned and tighten the screws and nuts on both Bearing Blocks. Replace the Swing Arm Pivot Stud and tighten its Locknut. **NOTE:** The Elevator Bellcrank may seem slightly snug on the Main Shaft. This is intentional and will free up properly on the first flight.

F. Test the Main Gear for vertical movement on the Shaft. There should be just noticeable movement of the gear between the lower collar and the bearing block. If not, loosen the collar above the lower Bearing Block and move it up just slightly and retighten. Slide the upper collar up against the bottom of the upper bearing and tighten it. The Main Shaft should now show no vertical movement, and the Gear just a very small amount.

G. Remove one set screw at a time from each retainer, apply a small amount of Loctite and reassemble.

H. Examine the Swashplate #0217 and **View #3** on the drawing for control ball positioning. Using a small amount of Loctite on each, thread four 3x8mm thd Balls #0109 on the inner ring of the Swashplate. Note there are more than four

holes. Use any four that provide positions 90° apart. Mount one 3mm Double (3x10.5) Ball #0111 in any hole in the Swashplate outer ring, and three 3x6mm Balls #0107 in the remaining holes. Loctite each.

You will see that each corner of the lower swashplate ring has an M3 hole provided for lower bearing load adjustment. The procedure is quite simple. Apply Loctite to an M3x3 socket set screw and install it in one of the holes provided in the lower ring. Snug it up just until you feel a slight notchy sensation while rotating the bearing, then back it off about 1/8 of a turn. Repeat this for each of the four positions, checking your work by rotating the bearing when done. After extensive flying time, this procedure can be utilized on the helicopter to maintain a good tight feel of the swashplate.

I. Take the two washout control arms #0221 from Bag #4 and the two M3x8 Balls #0109 (longer shank) from the parts bag. Thread a ball into the hole in the long end of each Arm from the flat side. Use Slow Cyano. Make sure the balls are threaded squarely in place and lightly seated against their flanges.

J. Press Ball Bearings #0159 (X-60) or Bushings #0131 (X-50) into both sides of the center holes in both Control Arms.

K. Using two Special Washout Arm Studs, and carefully following **View #3** on the drawing, screw the Arms to the Washout Center Hub #0219. (Suggestion: squarely start the thread of each Stud into its hole in the Hub part way first without the Arm.) The control Balls should face inward. Tighten entire assembly until there is no lateral play and no bearing drag.

L. Remove the two Special Washout Links #0223 from Bag #4 and, using two Pivot Pins #0225, assemble the Links to the Control Arms. Their orientation is shown in **View #3** on the drawing. Note that they mount on the short ends of the Arms, projecting inward. The pins press in place centered in the links. Using a Heat Gun, blow heat on the pivot pin area until the arm and the link pivot freely. Do NOT damage with too much heat. Apply a very small amount of slow cyano glue or J.B. Weld Epoxy on each end of the pins. Be careful not to get any glue between the control arms #0221 and the links #0223. **THEY MUST PIVOT! See View #3.**

M. Complete four control rods #0227 by threading a plastic ball link #0133 on each end. The length of the finished rods is determined by laying them over the precise full scale view on the control rod length chart on the drawing. The rods must be identical in length. As a check dimension, the length of metal rod between inner plastic link faces is 20.5mm. Refer to **Figure #10. IMPORTANT NOTE:** If you are utilizing main shaft #0614 (10.0mm longer than #0203) the following control rod lengths must be adhered to exactly. Each measurement given will be the length of metal rod exposed between each inner ball link end. **NOTE:** Be sure equal amounts of threads are exposed.

Shaft #0614 used with **no** #0210 spacer (full length) -- 29.5mm
Shaft #0614 used with (1) #0210 spacer (full length less 5.0mm) -- 27.0mm

N. Referring to **View #11** on the drawing for control rod placement, snap the ball link on one end of a rod to the OUTSIDE ball on each of the double balls mounted to the Elevator Bellcrank. Similarly, snap a ball link on the longer of the balls on each Roll Bellcrank.

O. Slide the Swashplate on the Main Shaft. Holding the four control rods up, snap the four top ball links to the outer Swashplate. Be sure the double ball on the Swashplate faces to the **LEFT.** The link from the left Roll Bellcrank should be snapped on the **INNER** ball.

P. Slide the Washout assembly on the Main Shaft and snap the Washout Links to two balls on the inner Swashplate. Refer to **View #3** for orientation.

Step 6. Assemble and Install Front Tail Drive

Parts Required:

1 #0239 Front Drive Pinion Shaft	Bag #5
2 #0233 Front Drive Housing Halves	Bag #5
2 #0235 Ball Bearings, Front Drive (M5x15)	Bag #5
1 #0237 Retainer Collar	Bag #5
1 #0231 Front Drive Pinion Gear	Bag #5
2 #0241 Housing Guide Sleeves	Bag #5
2 #0077 M3x30 Socket Hd Cap Screws	Bag #5
4 #0003 M3 Flat Washers	Bag #5
2 #0019 M3 Locknuts	Bag #5
2 #0051 M3x3 Socket Set Screws	Bag #5

Special Material Required: Grease, Teflon Filled

A. Place one Front Drive Housing Half #0233 flat face down on a hard surface and press both Housing Guide Sleeves #0241 into the holes provided. Refer to **View #4** on the drawing. Insert both Sleeves until flush on the bottom.

B. Place both Ball Bearings #0235 on a clean surface with the ball races exposed. Moderately pack both bearings with grease (order part #4707). Pick up one bearing, turn it over and place it over the other bearing, retaining the grease between them.

C. Select the Front Drive Pinion Shaft #0239 and, grasping both bearings at once, slide them on the long end of the Shaft as far as they will go.

D. Slide the rear bearing back until the Shaft and bearings can be inserted onto the Housing Half (with sleeves) with the bearings fully seated on either side of the center section of the Housing Half. The remaining Housing Half can then be aligned over the Guide Sleeves and pressed in place to fully retain the bearings. **Do not force!** If bearings are properly seated, the assembly will close completely with the Guide Sleeves flush on both sides.

E. Place a small amount of Loctite on one M3x3 Socket Set Screw and thread it part way into the Retainer Collar #0237. Slide it on the long end of the Shaft until it contacts the bearing and tighten moderately. Be **CERTAIN** no Loctite can get to the bearing. Also be sure the other bearing is solidly seated against the flange on the Shaft. Check for a free rotation, loosen collar if binding is noticed.

F. Slide the Drive Pinion Gear #0231 loosely on the long end of the Shaft (the set screw will be added later).

G. After referring to **View #4** on the drawing, install the subassembly in the Frame assembly, using two M3x30 Socket Head Cap screws, four Flat Washers, and two M3 Locknuts. Push the unit up as far as the screw slots will allow. Do not tighten.

H. Determine that the Front Tail Rotor Drive Pinion is properly in place and engaging the teeth on the upper face of the Main Gear. Apply a small amount of Loctite to two M3x3 Socket Set Screws and thread into the Pinion Gear. By sliding the pinion in or out on its shaft and by sliding the Front Drive Housing up or down, find a position giving smooth gear engagement. This procedure is very important to ensure a correct gear and drive shaft alignment and durability. DO NOT take alignment for granted even if gear mesh seems smooth. The output shaft #0239 needs to be parallel with the main gear. Also, sight line-up of block to determine that the output in #0239 for tail rotor drive shaft is straight and in the center of the front tail tube plastic blocks #0185. A small piece of 2mm wire (approximately 2" long) can be inserted in the output shaft for additional line-up help. (**NOTE:** Tail rotor drive shaft should insert into #0239 output shaft easily when assembling tail tube assembly to main frames.) Front pinion gear should have slight amount of rotational play in the main gear and operate freely. Tighten the two Housing bolts and the Pinion set screw. Make sure the set screw engages the FLAT on the shaft when this is done. Do not over tighten the housing bolts. Over tightening will cause pressure on the bearings.

I. Set the Frame Assembly aside temporarily.

Step 7. Assemble Engine and Clutch

Parts Required:

1	#0253 Cooling Fan Shroud - 2 pcs		Box
1	#0255 Cooling Fan (assembled)		Bag #6
1	#0007 Special Engine Washer (M6.6x12.3)		Bag #6
1	#0261 Aluminum Fan Spacer (X-50 only)	*	Bag #6
1	#0263 Fan Drive Collet 1/4" (X-50)	*	Bag #6
1	#0264 Fan Drive Collet 1/4" (X-60)		Bag #6
1	#0285 Starting Cone		Bag #6
1	#0267 Centrifugal Clutch - Shaft		Bag #6
1	#0275 Clutch Bell with Pinion		Bag #6
2	#0273 Clutch Spacer Washer		Bag #6
4	#0078 M4x12 Socket Hd Cap Screw (X-60)		Bag #6
2	#0081 M4x16 Socket Hd Cap Screw (Clutch)		Bag #6
4	#0067 M3x14 Socket Hd Cap Screw (X-50)	*	Bag #6
2	#0063 M3x8 Socket Head Cap Screw		Bag #6
2	#0053 M3x5 Socket Set Screw		Bag #6
4	#0029 Phillips Sheet Metal Screws 13mm		Bag #6
2	#0031 Phillips Tapping Screws (M2.9x6.5)		Bag #6
1	#0005 Special Engine Washer (M7.4x14)		Bag #6

Additional Requirements:

1 #0265 Special Order - Fan Drive Collet Enya .60 (ONLY)
1 #0266 Special Order - Fan Drive Collet (8mm)
1 2-Cycle Glow Engine of your choice
1 Matching Muffler - Helicopter Type
1 Recommended Glow Plug

Special Tools Required: 1 Dial Indicator or equivalent (for testing fan runout)

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 settings are more easily done on a test bench.

B. Measure the shaft diameter of your engine. The precise centering of the fan and clutch assembly is achieved by the use of a special collet #0263 or #0264 whose bore must fit your engine. The collet provided in both X-Cell .50 and .60 Kits has a .250" bore. This will fit the majority of engines commonly selected for helicopter use. If you engine shaft 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! (Radios 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 (X-60) and 18mm (X-50). When cutting, cover all open engine surfaces.)

C. Remove the prop nut and washer from your engine. Place the #0255 Cooling Fan on the engine shaft (if an X-Cell .50, place an #0261 Aluminum Fan Spacer on the shaft first). Place the proper Fan Drive Collet #0263 (in kit) or #0265 (7mm, optional), or #0266 (5/16" or 8mm, optional) on the engine shaft, **SMALL** end down. Center the Fan to engage the collet, slide #0007 or #0005 Engine Washer on the shaft 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.

D. Using whatever device is available, - a machinists Dial Indicator is shown in **Figure #4** - determine that the Fan runs square and true when the 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 a less than .06mm (.002") excursion of the needle during a full rotation of the engine shaft. **NOTE:** Two threaded holes are provided in the Collet for removal. To remove, select a piece of 1/8 aluminum or steel at least as wide as the aluminum fan hub top surface and drill two 3mm holes in the center, matching the holes in the collet. Apply tape to the fan hub surface for protection. Guide two 3mm bolts through the plate and into the collet and tighten for easy extraction. (See **Drawing A** at the end of instruction booklet). If difficulties persist in aligning the fan unit, refacing the knurled engine prop driver with a lathe will help the alignment process. Many of the knurled engine prop drivers do not run true.

E. After alignment, the prop nut must again be tightened very securely to prevent slippage during engine start or backfiring. 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 indicating reading may occur as the fan nut is increasingly tightened. It is very 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 clutch face is clean and install it on the Cooling Fan, using two M4x16 Socket Head Cap Screws. Seat it properly and tighten the screws. 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° and retightening. 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. **See Figure #4.** Once aligned, remove the screws one at a time, apply Loctite, and replace. Tighten securely.

G. Remove the Motor Mount from the Frame Assembly and examine it, comparing its threaded mounting holes to the hole pattern on your engine. The Mount included in an X-Cell .60 Kit will fit all normally used .60 class engines. The Mount included in an X-Cell .50 Kit will fit all .50 class engines with one exception - an OS .50 FSR engine is unique and requires a special mount. This part is available through your dealer or direct from Miniature Aircraft USA. **NOTE:** Engine mounts are reversible for mounting height versatility.

H. Next, drill all mounting holes in the .50 engine to .138" (#29 drill - 3.5mm) and the .60 engine to .182" (#14 drill - 4.5mm). This allows extra movement of the engine for alignment in side frames. Fit the engine to the motor mount using four M4x12 Socket Head Cap Screws if a .60 size, and four M3x14 Screws if a .50 size engine. Do not tighten.

I. Slide the Clutch Spacer #0273 over the Clutch Shaft, followed by the Clutch Bell/Pinion #0275. Referring to **View #5** on the drawing, remove the previously mounted Start Shaft Bearing Block, and slide the engine into position between

the Main Frames of the helicopter structure. The top of the shaft should project between the frames just ahead of the Main Shaft. **NOTE:** With some brand engines it may be necessary to remove the **complete** landing assembly from the frames for easier engine installation. Loosely secure the engine using six (M3x10) Socket Head Screws and Flat Washers screwed through the slots in the frames.

J. Reassemble the Start Shaft Bearing Block #0198, sliding it on the shaft, bearing end down, until it can again be retained by two M3x30 Socket Head Screws mounted through the two horizontal slots in the top of the frames. Use an M3 Flat Washer on each side and secure with M3 Locknuts. Do not tighten. **IMPORTANT:** The #0198 block should slide onto the start shaft, centered in between the side frames. Re-adjust engine mounting until this is achieved. **See View #5.** If there is any clearance between the side frames and the sides of the #0198 block, add equal layers of blade covering material or vinyl tape to each side of the block until the fit is snug in between the frames, with all engine and motor mount bolts tight.

K. Thread two M3x5 Socket Set Screws into the Starting Cone #0285, obtained from the parts bag, and slide on the shaft. Lift the engine assembly up with your fingers until the top of the Clutch Bell Pinion engages the bearing in the Bearing Block fully, and the pinion is in loose engagement with the Main Gear. Tighten one set screw in the Starting Cone to suspend the engine in place. Slide the Shaft Bearing Block toward the Main Gear in its slots until the pinion fully engages the main gear with just slight play. Check to see that the engine hangs vertically and tighten the bolts through the Shaft Bearing Block. Tighten the six bolts holding the Engine Mount between the frames and, finally, tighten the four engine-to-mount bolts. The engine shaft should turn without bind and the main gear should rotate freely in engagement with the pinion. Apply Loctite to all screws and set screws in Starting Cone and Motor Mount areas.

L. An ideal condition exists when the Clutch Bell has slight vertical play and a strip of tissue paper will just pass through the Main Gear-Pinion Tooth mesh when the mesh is at its tightest position. Tighten both starting cone set screws and retighten all engine screws.

M. Remove the two piece Fan Shroud #0253 from the box and experimentally hold the pieces in their proper position around the Fan inside the Frame members. It is possible that a portion of the underside - even including the inside screw boss - will have to be cut away to clear some engine carburetors. If so, carefully do so, allowing enough of an opening into the shroud duct for good carburetor breathing. Once complete, the Shroud halves can be screwed together (around the Fan) using either three or four of the Phillips Sheet Metal Screws from the parts bag. Take the remaining two M3x10 Socket Head Screws and mount the Shroud in place using the side frame slots provided. **Refer to View #5.** Before tightening, slide the Shroud up until it is flush with the bottom face of the Fan. There should be slight but adequate clearance for Fan rotation and the front of the housing should be against the rear of the Front Frame Support. Using a #43 or #44 drill or equivalent 3/64", drill two holes through the Frame Support holes provided and anchor the Shroud to the Support with the two remaining 6.5mm Phillips Self-tapping screws. Recheck for fan clearance and tighten all four Shroud screws.

Step 8. Complete Main Frame Structure

Parts Required:

2 #0245 Lower Canopy Support Studs	Bag #6
1 #0247 Radius Arm Support	Bag #6
1 #0107 M3x6 Thd Ball	Bag #6
1 #0249 M2x42 Control Rod	Bag #6
2 #0133 Plastic Ball Links (Long)	Bag #6
4 #0063 M3x10 Socket Hd Cap Screws	Bag #6
2 #0019 M3 Locknuts	Bag #6

A. IMPORTANT NOTE: If you have determined that your kit contains mainshaft #0203 or you are choosing (2) #0210 plastic spacers as an option with #0614, follow these steps: take the radius arm support #0247 from Bag #6 and bolt it in position on the top left main frame as shown in **View #2.** Use two M3x10 socket head bolts and M3 locknuts.

If you are using main shaft #0614 with no #0210 spacers or just one, follow these preliminary steps:

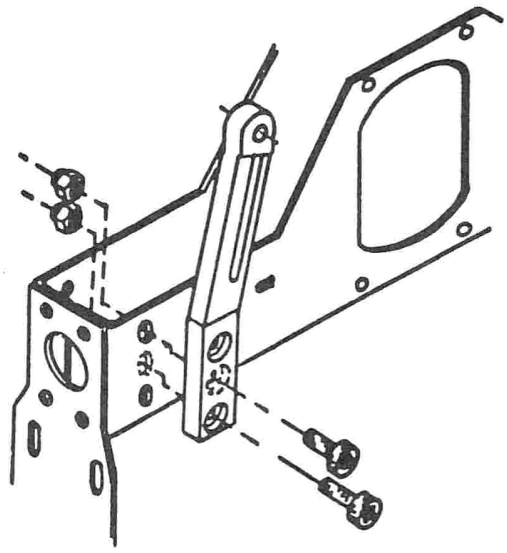
Drill a new hole 15.5mm from the bottom of support #0247 (directly between the existing holes) with a #32 drill (.116" or 3.0mm) completely through. Make a countersunk hole at half depth using a #3 drill (.213" or 5.5mm) and light pressure. **See View #2A Alternate** (next page).

Drill a new hole in the left main frame directly between the two existing support mounting holes (16.0mm from the top or bottom edge) with a #32 drill (.116" or 3.0mm).

Install anti-rotation support #0247 using the upper two holes in the frame and lower two holes in the support. This will raise the support by about 9.0mm (thereby accommodating any additional main shaft length).

When mounted, thread the M3x6 threaded ball in place in the top hole in the support from the outside. Use cyano as described earlier.

VIEW (2A) ALTERNATE



B. Thread the Plastic Ball Links on the M2x38 Control Rod #0249 to the length that matches the Radius Arm Rod length in the Control Arm chart. The reference dimension for the length of the Rod between the Ball Links is 23mm. Snap this Rod on the Radius Arm Support ball end and onto the outer (only remaining) ball of the double ball on the Swashplate. Refer to **View #11.**

C. Mount the two Lower Canopy Support Studs to the forward holes in the sides of the Tank Support Tray using the remaining M3x10 Socket Head Screws. Use Loctite. Tighten securely. Cut two 12mm lengths of fuel tubing (supplied with tank) and press them fully on the ends of the Studs. These will provide resilient Canopy mounting. Refer to **View #2.**

D. Set the Main Frame Structure aside until final assembly.

III. RADIO TRAY ASSEMBLY

NOTE: **While the standard arrangement is for conventional single throw collective, this tray has special provision for conversion to push/pull collective. Should you desire this arrangement, it is necessary to purchase (separately) the #0576 Push/Pull Conversion package containing the bellcrank and hardware along with special supplemental instructions.**

Step 1. Assemble Plastic Radio Tray and Install Servos

Parts Required:

4	#0575-1 Servo Screw Doubler (20.0x8.0x5.0mm)	Bag #7
2	#0573-3 Rudder Servo Block (20.0x8.0x9.0mm)	Bag #7
1	#0575-4 Upper Servo Plate (holds rudder, ail, and collective servos)	Bag #7
1	#0575-5 Lower Main Plate (holds receiver and battery)	Bag #7
1	#0575-6 Main Vertical Support (holds throttle servo)	Bag #7
1	#0575-7 Secondary Vertical Brace ("H" shaped)	Bag #7
1	#0575-8 Switch Plate	Bag #7
2	#0063 Socket Head Cap Screw (M3x10)	Bag #7
4	#0065 Socket Head Cap Screw (M3x12)	Bag #7
8	#0019 M3 Locknuts	Bag #7
2	#0089 Hexhead Bolt (M3x10)	Bag #7
17	#0027 M2.2x9.5 Self-Tapping Screws	Bag #7
2	#0029 M2.2x13 Self-Tapping Screws	Bag #7
4	#0035 M2.2x16 Self-Tapping Screws	Bag #7
4	#0001 M2 Flat Washer	Bag #7
1	#0347 Tray Frame Support, Upper	Bag #7

2 #0349	Tray Frame Support, Lower	Bag #7
2 #0353	Roll Servo Pivots (Female)	Bag #7
2 #0351	Roll Servo Pivot Supports (Male)	Bag #7
2 #0357	Plastic Pivot Grommets	Bag #7

Additional Requirements: 1 Helicopter radio, complete with 5 servos and mounting hardware.

A. Examine exploded **View #6** showing the placement of plastic parts in the Radio Tray. Also refer to **View #8** showing servo placement. Examine the #0575-5 Lower Tray. You will see that long, thin slots are molded in the front and rear of this part. If you are going to install the tray on an X-Cell .50 or .60, it is necessary to cut through the slots at the rear of the lower tray thus removing the last 20.0 clearance for the #0349 Lower Support Brackets.

B. Servo Installation: The order of assembly of the various plastic parts is not critical; however, experience has shown that it is more convenient to initially fit the servos prior to overall assembly. The reason for this is due to the adjustable nature of servo openings. Obviously this tray must accept all popular servo sizes, so the following will outline each servo installation.

C. Select the Upper Servo Tray #0575-4 from Bag #7. Referring to **Views #6 and #8** mount the servos as follows:

1. **Rudder Servo:** Select two plastic spacer blocks #0575-3. Using the original servo hardware, mount the blocks to the servo allowing at least 1.0mm of servo case clearance. Apply a thin coat of cyano (flex, poly, slow, or gap filling type) to the underside of each block and set the asembly into position on the tray. The output position of the servo is to the rear of the tray. Align the center hole on each block #0575-3 with the center slot provided on each end of the rudder opening. From the underside of the upper servo tray #0575-4 install a #0027 M2.2x9.5 Phillips Screw into each center hole. Center the servo within the opening and tighten all four servo screws previously installed.

2. **Collective Servo:** If you are **not** opting for the push/pull conversion, the collective servo will be installed directly on top of the upper tray without any spacers, but with the $0575-1 Doubler Blocks. In this installation, the servo output will again be to the rear of the tray. Using original servo hardware, position the servo in the opening flush on the top surface followed by the #0575-1 Doubler Blocks from beneath the top tray with cyano as above. Again, adjust for case clearance before tightening the servo screws and letting the cyano cure. As with the rudder servo, the collective servo can be removed without losing it's position if you like.

3. **Roll (Aileron) Servo:** Note that the aileron (roll) servo is mounted on pivots to allow it to rock fore and aft under control of the collective pitch servo ahead of it. **View #7** shows the pivot structure. Select the servo to be used for Roll control and install all four rubber grommets. Select a #0351 Roll Servo Pivot from the parts bag and, holding it in place under one end, use a small drill to mark it for proper hole drilling to accept two of the servo mounting screws from your radio hardware. (**NOTE:** Recognize that screwing this servo to the Pivot is just like screwing the servo down to a wood or plastic servo tray in that a small enough drill must be selected to allow your particular screws to thread into the plastic.) Drill the holes and screw the Pivot to the servo. In identical fashion, mount the remaining #0351 Pivot to the other end of the servo. Press two #0357 Plastic Pivot Bushings into the holes in the two #0353 Roll Servo Pivots. Again referring to **View #7**, hold the servo in approximate postion centered in its clearance hole in the tray and press the bushings of the Pivot Supports inot the servo Pivot ends (lightly grease).

Rotate each #0353 servo pivot into their respective position on the underside of the upper tray #0575-4. Hold the entire servo assembly and the upper tray together. Allow no side play in the servo and center the output spline with the true center of the tray (the rear hole for the screw to the vertical support #0575-6 is true center). Lightly cyano glue the pivot supports #0353. Re-check the servo for alignment, good retention end-wise and freedom to pivot. Glue securely. From the top side of the upper tray drill two small holes through the slots provided into the servo pivots #0353. Secure using four #0027 (M2.2x9.5) self-tapping screws.

4. **Throttle Servo:** Select the vertical tray support #0575-6. Mount the throttle servo with the splined output shaft towards the rear. Secure servo using four #0035 (M2.2x16) Phillips tapping screws, four #0001 (M2) washers, and two #0575-1 doublers. Cyano doublers from the back side.

D. Overall Assembly: refer to **View #6** for overall positioning of all plastic parts. It is best if a thin line of cyano is put on the mating surfaces prior to installation of the screws. Using two #0027 (M2.2x9.5) Phillips self-tapping screws, fasten the vertical tray #0575-6 to the underside of the upper tray #0575-4. Secure the secondary vertical brace #0575-7 ("H" shaped) to the front side of the vertical tray #0575-6 using one #0027 (M2.2x9.5) screw. Mount the vertical brace with the screw eyelets pointing forwards (towards the helicopter's nose). Position the main lower plate #0575-5 and secure using two #0029 (M2.2x13) Phillips tapping screws through the front two holes in the upper servo plate #0575-4. Use #0027 (M2.2x9.5) in the remaining four holes on the bottom side.

The switch plate can go in either of two positions using two #0027 screws. One will place it to the left rear of the tray, allowing switch access from behind the canopy near the main gear area. The other position will place it alongside the rudder servo. This position is good for some fuselages or when you choose to have a small access hole in the canopy side window area.

E. Identify the placement of the Upper #0347 and two Lower #0349 Tray Frame Supports on the Drawing **View #6** fo the Main Frame Assembly. Take these parts and the necessary M3x10 screws and M3 nuts from the parts bag and assemble loosely in place in the slotted holes on the #0175 Front Support Plate. **NOTE:** The lower two wood brackets use two #0089 hex bolts (M3x10) from the inside out on #0175 for clearance of fan shroud.

F. Note that the upper tray mounting holes for attachment to the front frame plate are slightly elongated. This allows proper fitting to both .30/.40 and .50/.60 X-Cells. In either case, push the tray up against the frame vertical front plate. and assemble loosely in place using two #0065 (M3x12) socket head bolts and two #0019 M3 locknuts.
As previously mentioned for .50/.60 installation, the lower tray was trimmed for clearance of the lower metal brackets #0349. In this installation, utilize the (2) 3.0mm holes lowest in the tray with two #0065 (M3x12) socket head bolts and two #0019 M3 locknuts. Once again push the tray up against the frame vertical front plate #0175 and securely tighten all four #0065 bolts.

G. Check servo clearance in the cutout of the #0365 Elevator (Pitch) Servo Mount and increase if necessary. Drill for servo mounting as required. Mount the servo using the four sheet metal screws provided. Install the mount under the top Front Boom Support screws and the Elevator Pivot Arm Bolt on the right side. See **Views #2 and #11**. Add the M3x8 screw and M3 hex nut in the front hole. Do not tighten.

IV. TAIL ASSEMBLY

Step 1. Assemble Tail Rotor Transmission and Collective

Parts Required:

1	#0421 Tail Rotor Gear Hosing (2 pcs)		Bag #8
1	#0423 Input Shaft, Tail Rotor		Bag #8
4	#0425 Ball Bearings (M5x13)		Bag #8
2	#0427 Bevel Gears		Bag #8
1	#0429 Output Shaft, Tail Rotor		Bag #8
1	#0431 E-Clip, Output Shaft		Bag #8
1	#0433 Gear Spacer, Output Shaft		Bag #8
1	#0435 Brass Control Slider		Bag #8
1	#0437 Plastic Control Slider Ring		Bag #8
1	#0101 Threaded Steel Ball (M2x5)		Bag #8
2	#0439 Ball Bearings, Control Ring (M6x10)		Bag #8
1	#0441 Plastic Pitch Plate, Tail Rotor		Bag #8
1	#0443 Snap-On Retainer, Pitch Plate		Bag #8
2	#0133 Ball Links Long		Bag #8
1	#0445 Bellcrank, Tail Rotor		Bag #8
1	#0095 Special Bolt, T/R Bellcrank (M3x19)		Bag #8
2	#0159 Ball Bearings (M3x7) (X-60)		Bag #8
2	#0131 Plastic Bearing Bushing (X-50)	*	Bag #8
2	#0001 2mm Washers		Bag #8
1	#0446 Steel Tail Hub		Bag #8
1	#0447-2 Delta Hub Pivot Pin		Bag #8
1	#0449 Dampener Rubber		Bag #8
2	#0299 Ball Bearings (M4x10)		Bag #8
2	#0019 M3 Locknuts		Bag #8
6	#0446-3 Special Shims		Bag #8
4	#0447-1 Spring Lock Clips		Bag #8
2	#0453 Tail Rotor Blade Mounts		Bag #8
2	#0103 Threaded Steel Balls (M2x5)		Bag #8
2	#0457 Thrust Bearings, Blade Mounts		Bag #8
2	#0463 Tail Rotor Blades (X-60)		Bag #8
2	#0461 Tail Rotor Blades (X-50)	*	Bag #8
4	#0025 Phillips Self-Tapping Screws (2.2x6.5)		Bag #8
2	#0041 M2x8 Machine Screws		Bag #8
2	#0073 M3x20 Socket Head Screws		Bag #8
2	#0019 M3 Locknuts		Bag #8
1	#0053 M3x5 Socket Set Screw		Bag #8
4	#0051 M3x3 Socket Set Screws		Bag #8

A. **View #9** on the drawing shows the parts that make up the bevel gear transmission and tail rotor pitch control unit. The assembly sequence to follow is intended to allow convenient balancing of the tail rotor.

B. Parts placement to make up the Tail Rotor collective pitch control is also shown in **View #9**. Begin by threading the #0101 Short thread (M2x5) Ball into the side hole of the #0437 Control Ring. Use cyano and thread the ball squarely in place.

C. Place the two #0439 Ball Bearings (M6x10) on a clean paper with the balls visible. Lightly grease each.

D. Slide one bearing on the #0435 Brass Control Slider, ball side last. Lightly slide the Control Ring over the Slider, followed by the other bearing, ball side FIRST, 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.

E. 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 too tight nor too loose. The control ring bearings are precise and delicate but necessary for a tight slop free tail rotor control. This will be achieved by using the following procedure.

F. 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 vertically 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 endplay. Apply cyano to retainer clip.

G. Screw #0133 Ball Links to the Pitch Plate using M2x8 Machine Screws. Just seat the screws, so that the links can rotate with firm pressure.

H. **IMPORTANT:** Clean any oil from pivot pin #0447-2, set screw #0053, and output shaft #0429 before assembling. Select the #0446 delta hub, the #0447-2 grooved 2.0mm pivot pin and the #0449 dampener silicone tube from the parts bag. Examine **View #9** and **Figure #4** to see the correct orientation of the pivot pin to the tail blade assembly. This is most important. It will only fit two ways and one is wrong for proper function. Press the silicone tube about 10.0mm up over the end of the output shaft with the cross drilled hole. Slide the delta hub (with proper pin orientation) up onto the silicone. Now press both together up onto the shaft until the cross hole in the shaft appears to align with the 2.0mm through hole of the delta hub. Use a 1.5 allen wrench or small drill to pierce through the silicone dampener. Temporarily install the #0053 M3x5 socket set screw into the end of the output shaft. Test its hole depth by making sure it can contact a drill or 1.5 tool pushed all the way through the hub/silicone/shaft assembly. This will make sure no burrs are inside the threaded hole to prevent good contact during final assembly. Having made this test, remove the M3x5 set screw. Press the grooved delta pin #0447-2 into the assembly until equal parts are shown on each end of the hub. Drip Loctite (liberally) into the threaded hole and install the M3x5 set screw again. Select (2) #0001 M2 flat washers and (2) #0447-1 lock clips (extras are provided if you break one). Use a small piece of brass tubing or a 5.5mm nut driver to snap a lock clip on top of a M2 washer on each end of the grooved pivot pin. Be sure not to use pliers and that the clip reaches the groove fully. While this system can properly function without any clips at all, it will add additional security. Slide the control ring assembly on the output shaft from the grooved end, with ball links towards the hub. Snap each ball link in place. You will now see that an imaginary diagonal line (say, for instance, as 10:00 to 4:00) will pass through each control ball and the pivot pin.

I. Take the two #0453 tail rotor blade mounts from the parts bag and thread M2x5 Long Thread Steel Balls #0103 into the outboard holes, using slow cyano as before. **See View #9.**

J. Press **#0299 Ball Bearings** (M4x10) into the Mounts, on the root end, seating them squarely and fully.

K. Slide one #0453 Mount/Bearing Assembly up onto one of the exposed shafts of the hub. Examine the #0457 Thrust Bearing, noting that one race has a slightly larger I.D. than the other. Slide this race over the hub axle with the flat, ungrooved side towards the hub. Liberally grease the ball race and slide it in place. Follow with the remaining outer race (smaller I.D.) with the flat, ungrooved side outward, away from the hub. Using one #0019 M3 locknut to retain the assembly, trial fit to determine the need for any shims. Each kit is supplied with six #0446-3 special shims measuring .02x4.0x8.0mm. If, after trial tightening the nut in place, you find excessive end-play in the blade mount assembly, remove the nut and install up to three shims as required between the thrust bearing outer race and the nut. Once the correct shim (most will need one or none at all) is determined, the nut may be permanently installed. Install the #0019 M3 locknut and tighten but use common sense so as to avoid any breakage. Proceed with the other side of the hub.

L. Mount Rotor Blades #0463 (X-60) or #0461 (X-50), using M3x20 Socket Head Cap Screws and M3 Locknuts. Blades should be oriented for clockwise rotation with ball links leading the blade mounts. **See View #9.** Tighten just enough so that the blades will hold position.

M. To balance the entire rotating Tail Rotor assembly, ensure that the blades extend straight out from the hub and grasp just the Control Ring in two fingers, holding the rotor shaft level. The tail rotor should remain in any position if balance is correct (and the control ring bearings are properly free). If not, and one blade rotates downward, add weight in the form of a narrow strip of colored tape to the end of the **OTHER** blade bit until balance is achieved. Remove the blades and set aside. Make note from which side each tail blade was removed. **PROPER BLADE BALANCE IS ESSENTIAL.** A blade balancing device is available from Miniature Aircraft, USA, order #3750.

N. Lay the four Ball Bearings #0425 (M5x13) on a clean sheet of paper, ball side up, and apply a small amount of grease #4707 to the ball race of each. In sequence, on the narrow grooved side of the output shaft, slide a #0425 ball bearing (sealed side first), the #0433 gear spacer, and the #0427 bevel gear (teeth toward the E-Clip groove). Snap the #0431 E-Clip in the narrow slot at the end of the Output Shaft. Select one bearing and, ball side first, slide it on the short end of the Output Shaft up against the E-Clip. Apply a small amount of Loctite to each of two M3x3 Socket Set Screws and thread them part way into the boss of the bevel gear.

O. Refer to the drawing and select the bottom #0421 Gear Housing Half (cavity up - ear to the right). Place the Output Shaft in the cavity with the bearings at the extreme ends, with the E-Clip to the left. While pressing the Shaft toward the E-Clip to seat its bearing, hold the Gear and Spacer against the other bearing and tighten the gear set screws securely. Be sure one set screw is on the flat. There should be no endplay in the assembly.

P. Stack the remaining bearings with the ball sides together and slide onto the Input Shaft #0423. Thread two M3x3 Socket Set Screws in the remaining bevel gear, again using Loctite, and slide it on the Input Shaft with teeth side out. Separate the two bearings far enough on the shaft to allow insertion in the housing with the two bevel gears in mesh. The bearings should seat against the molded in spacer. Press this stack together and tighten both set screws in the gear.

NOTE: Be sure one set screw seats on the flat (load with grease #4707). The other Gear Housing Half can now be put in place and should rest fully against the first half. Secure together from the topside using 3 #0025 Phillips screws into the three holes at the rear of the housing and one #0025 Phillips screw in the front of the housing. The shafts should now rotate freely with no play. If desired, additional grease may be added to the bearing cavities before this step.

Q. Press either #0159 Ball Bearings (X-60) or #0131 Bushings (X-50) into the holes in the Tail Rotor Bellcrank #0445, using the Special Bellcrank Bolt #0095 to keep the bearings or bushings aligned during the process. The bearings should have ball sides facing in. Engage the control Ring Ball in the cup end of the Bellcrank and squarely thread the Stud into the boom on the Gear Housing from the bottom. Use cyano with care. Tighten the stud until there is no play or bearing drag.

R. Recheck the complete assembly for smoothness of action and put aside.

Step 2. Assemble Tail Boom Drive Shaft Tube and Fins

Parts Required:

1 #0471 Tail Boom (X-60)		Bag #10
1 #0469 Tail Boom (X-50)	*	Bag #10
1 #0473 T/R Drive Shaft Tube, Brass (X-50)	*	Bag #10
1 #0474 T/R Drive Shaft Tube, Brass (X-60)		Bag #10
4 #0475 Drive Shaft Tube Guides (X-50 uses 3)		Bag #9
4 #0477 T/R Control Rod Guides		Bag #9
1 #0479 Stabilizer Mount		Bag #9
1 #0481 Stabilizer Fin		Bag #9
1 #0483 Rear Tail Boom Support Fitting		Bag #9
1 #0485 Vertical Fin (X-50)	*	Bag #9
1 #0486 Vertical Fin (X-60)		Bag #9
2 #0487 Clamps, Vertical Fin		Bag #9
2 #0079 M3x35 Socket Head Cap Screws		Bag #9
2 #0075 M3x25 Socket Head Cap Screws		Bag #9
1 #0071 M3x18 Socket Head Cap Screws		Bag #9
2 #0025 Phillips Self Tapping Screws (2.2x6.5)		Bag #9
4 #0043 M2x10 Machine Screws		Bag #9
4 #0015 M2 Hex Nuts		Bag #9
5 #0019 M3 Locknuts		Bag #9
1 #0003 M3 Washers		Bag #9

A. The brass Tail Rotor Drive Shaft Tube #0473 (X-50) or the #0474 (X-60) and the Tube Guides #0475 are shown in their proper position in the Tail Boom #0469 (X-50) or #0471 (X-60) in **View #10.** Sand the brass tube with 80 grit sandpaper before assembly. Assemble as follows: slide the four shaft tube guides (X-60) or three shaft tube guides (X-50) on the drive shaft tube, all oriented alike; equal distance between each and placing the outer two approximately 6mm (1/4") from each end. Anchor in place with epoxy glue only. slide the resulting assembly in position in the tail boom, approximately centering it for either the X-60 or X-50 and drip some cyano down the inner wall of the tube from each end in turn, holding the tube at the proper angle, and rotating it to allow the glue to flow down to bond the end Guides in place.

B. **View #9** will show relative placement of the Fin and Stabilizer and their supports on the tail boom.

C. Insert an M3x35 Socket Head Screw through the top front hole in the Vertical Fin #0485 (X-50) or #0486 (X-60) and through a Vertical Fin Clamp #0487 and loosely thread on an M3 Locknut. Insert an M3x25 Screw through the bottom front hole in the Fin and the lower hole in the Clamp and add a Locknut. Assemble the rear Clamp to the remaining holes in the Fin in identical fashion, with the exception that one #0003 3mm washer will be inserted in between the slot in the fin clamp #0487. **NOTE:** The #0079 bolt (3x35mm) must go through the M3 washer. **See View #9. NOTE:** This washer applies to the rear clamp ONLY.

D. Slide the Stabilizer Mount #0479 into approximate position on the Boom and press the Rear Tail Boom Strut Support Fitting #0483 over the lower ears of the Mount and anchor with an M3x18 Socket Head Screw and M3 Locknut. Tighten only lightly. Mount the Stabilizer to the top of the Mount with two Phillips Self Tapping screws #0025 from the parts bag.

E. Loosely mount the four Tail Rotor Control Rod Guides #0477 by wrapping them around the boom and securing each with an M2x10 Machine Screw and M2 Hex Nut. Mount one between the Fin and Stabilizer and two ahead of the Stabilizer. (The screws are long enough to allow the Control Rod to be snapped in from the sides when needed.)

Step 3. Install Tail Rotor Transmission

Parts Required:

1 #0491 T/R Drive Shaft (X-60)		Bag #10
1 #0489 T/R Drive Shaft (X-50)	*	Bag #10
2 #0057 Socket Set Screws (M4x4)		Bag #9
3 #0061 Socket Head Cap Screw (M3x8)		Bag #9

A. On the Input Shaft of the Tail Rotor Assembly note the two threaded cross holes in the large diameter. Select two M4x4 Socket Set Screws, apply Loctite, and thread them partially in place.

B. Identify the flat on one end of the Drive Shaft #0489 or #0491 and, orienting it so that it faces one of the set screws, insert the Drive Shaft in the end hole of the Input Shaft as far as it will go. Tighten the set screw LIGHTLY against the flat (make certain of this orientation) and then tighten the opposite set screw. **THEN** tighten the first set screw. **RECHECK** the tightness of **BOTH** set screws.

C. Lightly grease the Drive Shaft and slide it into the Tail Boom from the Fin end until the Tail Rotor Drive Housing enters the Boom. Press the Housing halves together and orient so that the ridge on the housing enters the notch. Push it on until transmission butts up against the tail boom. Now slide the Vertical Fin assembly back against the face of the Drive Housing and rotate it until the Housing can be screwed to the rear Vertical Fin Clamp, using three #0061 M3x8 Socket Head Screws. Thread the screws on squarely and use a small amount of cyano. Do not over tighten. Now tighten all four M3 bolts in the two Fin Clamps. **NOTE:** Tighten upper rear M3x35 bolt #0079 snugly against the M3 washer previously inserted in between tail clamp. Over-tightening will cause the upper two mounting holes in the tail transmission housing to pull together, resulting in separation of the tail housing halves. Tighten front fin clamp securely. The Vertical Fin should be at right angle to the Tail Rotor and its Shaft. Set the assembly aside.

V. RADIO TRAY AND TANK INSTALLATION

Step 1. Mount Fuel Tank to Main Frame Structure

Parts Required:

1 #0395 Fuel Tank with Cap	
1 #0397 Length Fuel Tubing	Tank
1 #0399 Inner Tank Retainer Plate	Tank
1 #0401 Fuel Clunk	Tank
1 #0403 Fuel Pickup	Tank

1	#0405 Fuel Vent	Tank
2	#0061 M3x8 Socket Head Cap Screws	Tank
2	#0017 M3 Hex Nuts	Tank

NOTE: Fuel Tank can be mounted using servo tape on top, back, and bottom rather than bolting in if desired. If using tape **DO NOT** drill mounting holes.

A. Remove contents of Fuel Tank #0395. This should include all tank parts listed above. Set the tank upright and draw a line exactly 64mm from its bottom (the bottom being the opposite end of the Fuel Cap).

B. Referring to **Figure #6 and View #2**, slide the tank under the Radio Tray with its bottom on the right side of the helicopter and the marked line at the edge of the Tray bottom strip (this will center the tank laterally). Slide the Tray down against the tank to hold it and, with the tank back against the bolt heads on the front of the frame member, drill through the mounting holes provided in the Tank Support Tray and through the Tank. **NOTE:** a piece of double sided tape between the top of the Tank and the bottom Radio Tray member is suggested. Use a **SHARP** 3mm drill.

C. Carefully clean up the holes in the tank from the inside and anchor the tank in position using the #0399 Inner Tank Retainer Plate, 2 M3x8 Socket Head Screws and 2 M3 Hex Nuts. **NOTE:** Well "deburred" holes in the tank wall are necessary for a leak-free tank.

D. Drill appropriate holes and mount the #0403 Fuel Pickup and the #0405 Fuel Vent fittings. The positions shown on the drawing are recommended. Carefully clean the Tank of all debris and install the #0401 Fuel Clunk using a 86mm cut piece of the Tubing provided.

E. Recheck Radio Tray position (level and back solidly against the Frame structure) and tighten all screws.

Step 2. Add Radio, Gyro, and Switches

Requirements: 1 Radio System (from **Step II-2**)
1 Rate Gyro System (recommended)

A. Consult the Radio System and Gyro System Manuals and mount the system elements. Suggested Receiver, Battery, Gyro, and Switch positions are shown on the drawing. These were selected to provide proper helicopter balance with typical systems, but other arrangements are possible. Note that the holes are provided for servo lead routing, etc. Neatly bundle all surplus lead lengths and anchor with tie wraps or other means. Be sure to follow Radio (AND Gyro!) System recommendations for protection against vibration. Run the antenna well clear of engine and servos. (Miniature Aircraft USA offers a "whip" antenna particularly well adapted to helicopter use.) Do not anchor the frame-mounted Elevator (Pitch) servo leads at this time. (The Servo Extension Lead from your Radio System probably had to be used here.)

B. Test the system and recharge batteries but do not be concerned with servo arms, or servo travel and control direction at this point.

VI. ROTOR HEAD AND TAIL ASSEMBLY INSTALLATION

Step 1. Mount Rotor Head

Parts Required:

1	#0091 Special Head Retainer Bolt (M3x16)	Bag #1
1	#0019 M3 Locknut	Bag #1
2	#0335 (M2x75) Hiller Control Rods	Bag #1
2	#0337 (M2x30) Flybar Control Rods	Bag #1
8	#0133 Nylon Ball Links - Long	Bag #1

A. Examine the Drawing **Views #1 and #3** showing the complete helicopter head. With the Swashplate and Washout Unit already in place on the helicopter Main Shaft from Step I - 6, slide the Rotor Head on the Shaft and down until the two pins engage the Washout slots. By holding the Main Gear and rotating and sliding the Head, bring the cross hole in the Head into alignment with the hole near the top of the shaft. (It may be necessary to clean plastic molding "flash" from this hole.) Insert the #0091 Head Retainer Bolt (this is a special hard pre-cut bolt with short threads) from the side having the round recess, and screw it through until it just emerges into the hex recess on the other side. Insert the M3 Locknut in this recess and, while holding it in position, screw the bolt through and tighten snugly. (The screw cannot be pushed through the assembly because the holes in the plastic head are deliberately tight for optimum retention.)

B. Prepare the two Control Rods #0335 and #0337 by threading #0133 Ball Links squarely on each end until the

Rods are at the exact lengths shown for them (Hiller and Flybar) in the Control Rod Chart, **Figure #10.** Reference dimensions between inside Ball Link ends are: (58.0mm and 9.0mm for the #0203 Standard Shaft and the #0614 Long Shaft using 2 #0210 spacers); (59mm and 8.0mm for the #0614 Long Shaft using one #0210 spacer); and (60.0mm and 8.0mm for the #0614 Long Shaft with **no** spacers (using full length). As with all Control Rods, be sure of adequate thread engagement at each ball link.

C. Snap the longer pair of Control Rods (Hiller) between the remaining balls on the Bell Mixers (the short #0109 threaded steel balls) and the remaining balls on the Inner Swashplate Ring. **IMPORTANT NOTE:** If you could see through the rotor head (as viewed horizontally from the side), you would see a slight "X" pattern formed by these two hiller rods. This is contrary to the pictures or drawings of the standard X-Cell plans because of the new Delta offset system included with your kit. Snap the shorter pair between the Flybar Control Arms and the Washout arms. **DO NOT ATTEMPT TO FLY THE UNIT UNLESS YOU FULLY UNDERSTAND THIS POSITIONING OF PUSHRODS.**

D. This completes the Head installation. For convenience in handling, do not remount the Main Rotor Blades until later.

Step 2. Mount Tail Boom and Engage Drive

Parts Required:

1 #0495 Tail Boom Support Strut (X-60)		Bag #10
1 #0493 Tail Boom Support Strut (X-50)	*	Bag #10
2 #0057 M4x4 Socket Set Screws		Bag #9
2 #0025 Phillips Self Tapping Screws (M2.2 x 6.5)		Bag #9

A. Study **Views #2 and #9** showing Tail Boom and Main Frame details. Take the Tail Assembly from Step IV-3 and slide it partly into position between the halves of the Front Tail Boom Support. Holding the helicopter so that the end of the Front Tail Drive Shaft is visible ahead of the Support, slide the Boom further while engaging the Drive Shaft in the hole in the Tail Drive. Slide the Boom further until its front edge is flush with the front of the Support. The Drive Shaft should project well into the Tail Drive but should not bottom. Sighting from the rear of the helicopter, rotate the Boom until the Vertical Fin is parallel to the Main Shaft, and tighten the four Support screws snugly. (The Elevator Servo Mount should be in place for this step.)

B. Identify the two frame holes through which the Front Tail Drive can be seen and visibly locate the drive shaft flat. Select an M4x4 Set Screw, apply Loctite and by holding it on an Allen wrench, screw it into one of the threaded cross holes in the Shaft. Be positive that the Flat on the Drive Shaft is felt under the set screw. Tighten ONLY until contact is made, then add the second M4x4 screw in the opposite hole and TIGHTEN. Then tighten the first screws. **(This SEQUENCE is important.)**

C. Loosen the screws holding the #0187 Front Strut Support in the Frames and slide the #0493 or #0495 Tail Boom strut in position over projecting boss. **Use slow epoxy glue or J.B. Weld only. (No cyano glues.)**

D. Loosen the screw holding the #0483 Rear Strut Fitting to the Stabilizer Mount and slide the assembly back until the Fitting can be inserted into the Strut. Again use epoxy but move the Stabilizer quickly back into good horizontal alignment before the epoxy sets up. Tighten the Stabilizer screw again. Drill a hole, one on each end of the Tail Boom support midway through the aluminum tube into the plastic fitting, using a #49 or 1.8mm drill bit. Install 1 #0025 screw in each hole. **See Views #2 and #9.**

Step 3. Mount Tail Rotor Control Rod and Guides

Parts Required:

1 #0375 Rear Tail Rotor Control Rod (M2x700)		Bag #10
1 #0377 Front Tail Rotor Control Rod (X-60) (M2x305)		Bag #10
1 #0379 Front Tail Rotor Control Rod (X-50) (M2x225)	*	Bag #10
1 #0385 Control Rod Coupler		Bag #9
2 #0137 Plastic Clevises		Bag #9
1 #0387 Front Rod Guide, T/R Control (2 pcs)		Bag #9
1 #0035 Sheet Metal Screw (M2x14)		Bag #9

A. Examine the #0385 Control Rod Coupler, noting that it will accept the Control Rods beyond their thread. The intent is to better support the Rods against bending. Use the Coupler to join the Rear and the proper Front Control Rods together. (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.

B. Stack the two part #0387 Front Rod Guides on the M2x14 Screw and screw it partly into position at the small hole on the left side frame per **View #11 and Figure #5.**

C. Screw a Nylon Clevis on each end of the completed Control Rod and (long end to the rear) snap it into each of the four Rod Guides along the Tail Boom and into the Front Rod Guide. **Refer to Views #10 and #11.** Bend the tail end of the tail rotor control rod approximately 168° in order to align with the tail rotor bellcrank. **Refer to Figure #12.** Snap the rear clevis in the middle hole of the Tail Rotor Bellcrank (use a 3mm piece of fuel tubing as a keeper). Adjust the positions of the four Rod Guides along the Boom to allow a free-sliding Control Rod and tighten their screws as well as the one in the Front Rod Support. (Use Loctite.) Do not attach to the Rudder (Yaw) Servo yet. Set the helicopter aside.

VII. CANOPY PREPARATION

Step 1. Assemble Canopy and Paint

Parts Required:

1 #0497 Canopy (2 pcs)	Box
1 #0499 Canopy Latch	Bag #11
1 #0500 Trim Decal Sheet	Box

1 #0502 Special Canopy Bonding Adhesive **(optional)**

A. Examine the two Canopy halves. Note that they have been die cut to minimize cutting and trimming operations before bonding together. It is still necessary to cut out the back, top and bottom portions along the molded-in guide lines. **Refer to Figure #8.** Use scissors and/or a motor tool or a hot knife (a small soldering iron fitted with a collet to hold an "Exacto" blade).

B. Clean the bonding surfaces of the Canopy parts carefully and moderately sand using 80 - 100 grit sandpaper. Apply glue (#0502) to one side only. Align the surfaces to be bonded and secure in place using masking tape or paper clamps. Re-check parts alignment. **See Figure #8.**

C. Cut small reinforcing strips and bond one at the end of the glue bead on the bottom of the canopy and the other just inside the upper end of the seam leaving room for the canopy latch. Refer to the drawing for placement. Allow 3-4 hours partial cure time, 24 hours full cure time.

D. Trim the canopy edge to 3mm (1/8") all around and sand all plastic edges smooth. (Protect the canopy surfaces with masking tape.)

E. Using glue #0502, mount the #0499 Canopy Latch in place. **Refer to Figure #8** for position.

F. Carefully wash the canopy with detergent. Mask the window area and paint as desired.

G. The decorative Trim Decal Sheet can be used to finish the Canopy as desired.

VIII. FINAL SET UP AND BALANCE

COMMENTS: As noted in the Introduction, this helicopter will only reach its high performance potential when used with a five-servo Helicopter Radio. Such radio systems are available from virtually all radio manufacturers and, while differing greatly in many respects, have the following features in common:

1. Five servo operation including Throttle and Collective Pitch functions on the same stick.
2. Servo reversing capabilities on most channels.
3. Adjustable servo "dual rate" selection for Elevator (fore and aft Pitch), Aileron (Roll), and Rudder (Yaw).
4. Separate amplitude adjustments (some very complex & switchable in flight) for Throttle and Collective Pitch.
5. An adjustable mixing function which couples Rudder (Yaw) with Throttle/Collective to compensate for torque-induced adverse yaw (the nose tried to turn left when power is increased and vice-versa).
6. A good Instruction Manual - perhaps the most important common feature of all.

It is vital that this Manual be read and understood before undertaking final helicopter set-up; not only to understand the way your radio provides the above functions but also to understand the various additional mixing functions your transmitter provides, and to learn the location of the various switches and adjustable pots (some hidden under back plates, etc.) which must be used in helicopter set-up.

The instructions that follow recognize the similarities and differences between radio systems and deliberately provide a basic "one-half stick collective/level swashplate/neutral tail rotor" control condition from which nearly all further adjustments can be made at the transmitter.

Step 1. Set Servo Neutrals at Transmitter

Refer to the Radio Manual for position of all switches and knobs for neutral set-up. This should include Aileron (Roll), Elevator, Rudder and any external pitch trims. Set invert, idle up, and throttle hold systems in the INHIBIT (OFF) mode. Set Throttle trim at the low end and set the Throttle at half stick. Set all dual rate switches in the "HI" position.

Step 2. Mount Servo Control Arms/Wheels

Parts Required:

1 #0043 M2x10 Machine Screw	Bag #11
1 #0001 M2 Washer	Bag #11
1 #0361 Steel Ball (M2) Hollow	Bag #11

The hardware and Control arm package in the Radio System
(For all servo correct directional travel see **Figure #10**)

A. Elevator Servo: Referring to Drawing **View #11 and Figure #13A**, mount a Servo Arm vertically upwards and parallel to the main shaft, projecting up. It should have holes out 10mm to 12mm. (**NOTE:** Most servo arms mount on splined (serrated) output shafts and may not have a neutral position exactly as needed. Pick the closest one.) Check for proper directional travel and reverse at transmitter if necessary. Forward stick pushes servo arm forward. **Refer to Figure #13.**

B. Rudder Servo: First check servo for proper directional travel. Right tail stick command pulls the pushrod forward. Reverse if necessary. Turn on tail rotor/throttle mixing function (sometimes called ATS). Switch the ATS switch in transmitter to "R" (right hand rotation). Adjust compensator dials to one-half or (#5). Check proper compensation direction by increasing the throttle stick. This should result in pulling forward like a right hand command. If incorrect, switch ATS switch to "L" and recheck. After check completion, return throttle stick to the one-half stick position. Pick a servo arm that has holes at least out to 11mm and mount it at 90° facing inward. The preceding rudder steps will enable equal tail rotor control in both directions at lift-off (one-half throttle stick). **Refer to Views #8 and #11 and Figure #13.**

C. Throttle Servo: Without disturbing the Throttle stick halfway setting, mount a 14mm arm straight downwards from the servo. At this time, consult your Engine Instruction, loosen and reposition the carburetor control arm so that it projects straight up (vertically) when the arm is in its mid-travel position (halfway between full throttle barrel opening and fully closed kill position previously set in section I-7. Check for proper servo travel direction. Push rearward to increase throttle. Switch if necessary.

D. Collective Pitch Servo: With the transmitter stick still at the one-half position, select a large servo wheel (not an arm) and rotate on the servo spline until a hole may be selected which is approximately 2mm rearward from 90° (neutral) to the right of the servo and 8 to 14mm out. Mount a #0361 steel ball using a #0015 M2 Hex nut, #0043 M2x10 machine screw and a #0001 2mm washer provided in Bag #11. (Use Loctite.) **See Figure #14.** The closer to 8mm towards the center of the servo the ball is mounted, the softer collective response will be. The farther out, the quicker collective will be. Some radio systems without electronic endpoint adjustments will need to be mounted towards the 14mm point in order to obtain enough collective travel. Proper directional travel pushes rearward to increase collective pitch. **Refer to Figure #13.**

E. Do not disturb the Aileron (Roll) Servo controls until the Control Rod installation is made.

Step 3. Install Control Rods

Parts Required:

1 #0359 Roll Servo Link Retaining Bar	Bag #11
1 #0101 M2x5 Threaded Ball (Short Threads)	Bag #11
2 #0361 M2 Hollow Steel Balls	Bag #11
2 #0045 M2x14 Machine Screws	Bag #11
5 #0015 M2 Hex Nuts	Bag #11
1 #0367 Elevator (Pitch) Control Rod (M2x60)	Bag #11
1 #0369 Collective Control Rod (M2x35)	Bag #11
2 #0371 Aileron (Roll) Control Rods (Bent) (M2x90)	Bag #11
1 #0373 Throttle Control Rod (M2x130)	Bag #11

2	#0389 Elevator Servo Lead Retainers	Bag #11
5	#0137 Plastic Clevises	Bag #11
7	#0133 Plastic Ball Links - Long	Bag #11
2	#0513 Wood Blocks Swashplate Adjustment	Bag #11

A. Aileron Servo: **Study Views #7, #8, and #11**, showing the special control arm assembly on this pivoting servo. Note that the three control rods running to it have their ball links trapped by the arm assembly and, therefore, must be fabricated first.

Identify the #0369 Collective Control Rod and the two #0371 Aileron (Roll) Control rods and install #0133 Plastic Ball Links on both ends of each. Proper lengths are shown on the Control Rod Chart as before. **(Figure #10.)** Snap #0361 Steel Balls (drilled version) in the Links on the bent ends of the two Aileron Rods. Orient so the holes are visible.

As shown in the drawing, insert the #0101 M2x5 Threaded Steel Ball in the center hole of the #0359 Roll Servo Link Retaining Bar from the bottom and secure it with an M2 Hex nut. Use Loctite.

Select a double ended Servo Arm from the Radio System hardware, long enough to match the 24mm hole separation on the Retaining Bar. If necessary, obtain an undrilled arm or wheel and drill and shape it to suit. Mount it exactly parallel with the servo lengthwise.

Insert an M2x14 Screw in each end hole of the Retaining Bar, slide an Aileron Rod Ball on each and secure with an M2 Hex nut. Snap the Collective Rod Ball Link on the center ball and mount the assembly of three Rods to the Servo Arm. Secure with two M2 Hex nuts from underneath the Arm. Tighten securely using a small wrench or long-nosed pliers. Use Loctite. Check the configuration against the drawing. (Collective Rod forward.)

B. Collective Servo: Maintaining the throttle transmitter stick in the one-half position, snap the Collective Control Rod, #0369, on the ball on the servo wheel. The Aileron (Roll) Servo should be exactly upright in its pivots. If not, re-adjust collective rod length. Next adjust both Aileron Rods, #0371, until the roll bellcranks, #0167, are parallel with the top of the side frames, #0163 and #0165, keeping both Aileron Rods the same length. **NOTE:** If the longer main shaft #0204 is used with zero or one spacer #0210, wooden blocks #0513 will NOT be used for swashplate spacing.

C. Swashplate: Insert the two 11mm wood blocks, #0513, (**NOTE:** Only one side is 11mm) between the top of the Frame and the bottom of the Swashplate. Slide the Swashplate down squarely against it. Refer to **Figure #11**. Now test the Aileron (Roll) (two) and Elevator Control Rods, #0227 (two), for proper length by lightly holding their free ball links against the steel balls on the Swashplate - Aileron and Elevator Bellcranks. Adjust lengths as necessary and snap all four in place. (**NOTE:** The lower elevator ball links snap onto the outer balls on the double steel balls #0113. The left Aileron upper ball link snaps onto the inner ball on the double threaded steel ball #0111.) The proper condition should allow the Swashplate to remain level at the 11mm position with all three servos (collective, aileron, and elevator) still centered. Now remove the small Pitch Scale decal from the Decal Trim Sheet and mount it on the left side of the helicopter on the frame surface just aft of the elevator bellcrank cutout, and vertically aligned with the cutout (see **Figure #9**). Finally check for proper Aileron Servo travel direction. Right Aileron command should tilt the Swashplate to the right. Refer to **Figure #13**. Change if necessary.

D. Elevator (Fore and Aft Pitch) Servo: Install a #0137 Plastic Clevis and a #0133 Ball Link on #0367 Elevator Control Rod using the dimension shown on the Control Rod Chart (**Figure #10**). Snap the clevis into the 8mm radius hole on the servo arm. Use a piece of fuel line as a safety retainer. Finally adjust the Control Rod, #0367, until the ball link aligns with the Elevator Bellcrank steel ball while still retaining the wood blocks under the Swashplate. After completion, remove wood blocks. Install #0389 Servo Lead Retainers on socket screw heads where appropriate to route the servo lead forward. Refer to **View #3**.

E. Throttle Servo: If the radio system has a throttle function called "Hovering Throttle" preset at neutral or "O" position. Using two Plastic Clevises and #0373 Throttle Control Rod, make up a Control Rod, snap one end on the Throttle servo arm and set the proper length to hold the engine throttle arm in the vertical up position. Operate the throttle servo and check for full carburetor closing and opening. Adjust radio endpoints (if equipped) or change servo arm length as necessary to achieve full travel. Use 2 fuel line safeties on clevises.

F. Rudder Servo: With throttle stick at one-half, snap the front control rod clevis into the servo arm 8 to 10mm from center. Check and adjust clevis 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. **See Figure #12**. Check both left and right tail rotor commands at low and high throttle positions for no binds. Adjust transmitter endpoints (if equipped) or change servo arm length if necessary. Safety both clevises with fuel line keepers.

Step 4. Final Swashplate and Flybar Alignment

Swashplate: A final check for a level swashplate may be achieved with the use of a main rotor pitch gauge (order #0526). Snap the flybar lock #0505 into the head position. Position the pitch gauge on one rotor blade and set the pitch

reading in the blade. Rotate the main rotor head in all four 90° positions. If the swashplate is truly level, the pitch reading will remain the same in all four quadrants. If incorrect, adjust the rods just below the swashplate until a level swashplate is achieved.

Flybar Paddles: Now that the swashplate has been leveled, the flybar paddles may be leveled also. Set your pitch gauge on 0°, position on paddle and adjust paddles until they are level (parallel) with the main rotor head. Each paddle and #0307 control arms must remain parallel to each other. **(VERY IMPORTANT)**

Step 5. Final Assembly and Balance

Parts and Equipment Required:
1 Helicopter Muffler or Tuned Pipe with Mounting Hardware
1 Yaw Rate Gyro

A. Install the Muffler or Tuned Pipe per its instructions. Connect a section of fuel line from the Tank clunk fitting to the carburetor, incorporating a fuel filter (not supplied) is recommended. Add a muffler to tank line again, with filter, if tank pressurization is desired.

B. Carefully read the gyro instructions provided. Mount the gyro selected on double layers of 2-sided vinyl servo tape on the upper wood tray just to the right of the collective servo. As far rearward as possible, check to be sure that the canopy and aileron tilting servo clears gyro body. Refer to **View #8**. Set gyro sensitivity to approximately 40-50%. Turn gyro and radio switches on and check for proper gyro/rudder directional 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. For a gyro installation behind the main shaft, order part #0595 - rear gyro mounting plates.

C. Balance: Check the completed helicopter by suspending it from the flybar (with the flybar crosswise) just above a level surface. With an empty fuel tank, it should remain level or tilt forward no more than 6 or 7mm (1/4") as measured over the length of a skid. Adjust battery pack position (or similar system element) to achieve this.

Step 6. Final Set Up

Comments: Your helicopter is now complete. There remains only the establishment of the proper control set-up at the transmitter. The Pitch, Roll, Yaw and Collective Pitch values recommended here have been arrived at after much test flying and work very well with both X-CELL SERIES .50 and .60 models.

A. Fore and Aft Pitch and Roll: The Elevator and Aileron servo arm lengths specified give full design travel. Dual Rates should be initially set at one half full travel. The Flybar weights give good aerobatics when fully out. Halfway settings provide fast response.

B. Yaw: The Rudder servo arm length given provides a very responsive tail. Experiment with Dual Rate adjustment until the set up with the particular gyro installed provides good but not extreme yaw response.

C. Collective Pitch: For best results to enable accurate pitch settings, a Flybar locking device should be used (order part #0505). Initially set the hover pitch setting in the main rotor blades (one-half throttle stick position) by adjusting the Hiller Rods, #0335, until +5° is achieved. Lengthen to increase pitch, shorten to reduce pitch. Do both blades. To achieve the remaining pitch curve setting, adjust the pitch trimmers on the transmitter or alter the collective servo arm length if necessary. The chart below gives adjustment degree values useable with both .60 and .50 models:

Low Stick --- minus 1° - soft landings, initial flights
minus 4° - aerobatics, autorotations
Half Stick -- plus 5°; .50 Series plus 5 1/2°

High Stick -- plus 8° - average engine
plus 9° - high performance engine and tuned pipe combination

Autorotation - plus up to 12° available depending on transmitter

Excellent INVERTED performance is obtained with the reverse of the above values (except autorotation!)

Low Stick --- plus 1° or 2°
Half Stick -- minus 5°; .50 Series minus 5 1/2°
High Stick -- minus 8 to 9°

Step 7. Additional Transmitter Adjustments (Optional) READ RADIO OWNERS MANUAL CAREFULLY.

A. Throttle Hold: With the throttle hold switch **on**, set the carburetor for a low reliable idle which will disengage the centrifugal clutch. Set throttle hold pitch curve for approximately -4° low to +12° high.

B. Idle Up: Some transmitters are equipped with multi-idle up switches. If only one is available, a higher idle-up setting will be necessary for some aerobatic maneuvers.

Multiple Switches:

1) Set approximately 50% throttle setting equal to hovering position. Low pitch range approximately -2°. (Loops, hovering, stall turns, rolling stall turns, general flying)
2) Set approximately 70-80% throttle setting. (Rolls, split S) Low pitch range. -3° to -4°.

Whichever idle-up settings you choose, set for constant blade speed during maneuvers. Fine tuning by flight testing will be necessary.

C. Invert Flight Set-Up: Activate the invert function on transmitter. With the roll servo exactly vertical, adjust the Hiller Pushrods #0335 until there is 0 collective pitch in both rotor blades. Set the transmitter throttle stick at one-half (Hover) and re-position the collective servo control arm at about (20) rearward from center (towards positive pitch side). Now flip the invert switch; the control arm position should move the same distance (20) from center towards the front (negative pitch side). Re-position until this is achieved. With the invert switch in the normal position for upright flying, choose a hole on the servo arm out 10-12mm from center and re-adjust the collective control rod #0369 until +5° (positive) is achieved at one-half throttle stick. Flip the invert switch to invert and check to see if the pitch readings are -5° negative. If not, re-adjust the collective arm length or collective servo control rod until equal-opposite (+ and -) pitch readings are achieved at hover. If only lower or higher equal-opposite pitch readings are obtained, the external transmitter pitch trimmer or hovering pitch trimmer can be adjusted and will increase or decrease both negative and positive pitch simultaneously. Now adjust high and low pitch settings as outlined in Step 4-D. Some radios have separate invert pitch curves available. Re-check all pitch settings before flying.

Step 8. Final Assembly Inspection

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

B. Re-check plans for proper assembly.

C. Inspect radio installation. Check to see that there is no mistake in the operational direction of each servo with no binds. Refer to **Figure #13.**

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. Refer to **Figure #13.**

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.

Step 9. Necessary Flight Items

A. Obtain items necessary for flight use

1) Glow fuel (Nitro; about 10 - 15%)
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) 12v charger
7) 1.5v glow plug batter 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

C. Starting and Stopping of the Engine

TO START: Always start the engine by using the transmitter trigger only (high throttle trim, low throttle stick). Connect the glow plug battery connection selected to the engine glow plug. Connect the start 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 starting 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 slowly enough to halt the rotor blades, then do so and remove the fuel line to stall the engine. In this case, re-adjust linkage until engine may be stopped by use of transmitter trimmer. (After daily use of your model engine, we recommend the use of an after run oil for engine protection.)

Step 10. First Flight Adjustments

A. Engine Carburetor Settings: With 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.

B. Throttle Adjustments: Fine tuning of the throttle may be done with the hovering throttle dial on your transmitter to ensure that from just before lift-off to hovering the helicopter will maintain a constant blade speed of approximately 1550-1600 rpm's. For best results, this constant blade speed should also be maintained during descent to hovering. The hovering trim dial will not affect the endpoints of the servo movements. This same effect can also be achieved with use of "idle up".

If your transmitter is not equipped with these functions, this effect will need to be achieved mechanically by different position relationships on the carburetor or servo arms. (**NOTE:** Rotor rpm's may be greatly affected by engine settings.)

C. Collective: 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.

D. 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

E. Radius Arm Adjustment: The radius arm control arm can be adjusted to mix small amounts of elevator or aileron together. The arm rod length given on the rod chart has been arrived at due to many flight tests. Any further adjustments will have to be arrived at by flight testing.

F. 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.

G. Tail Rotor Compensation: If the tail rotor swings during acceleration, the transmitter compensation dials need to be adjusted. When the nose swings to the right, LESS UP compensation is needed; nose to the left, MORE UP compensation is needed. Adjust compensation until tail remains stable during acceleration. DOWN compensation can be set during rapid descents.

H. 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.

NO.	I.D.	O.D.
0001	2.0	5.0
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
0025	2.2X6.5
0027	2.2X9.5
0029	2.2X13
0035	2.2X14
0051	M3X3
0053	M3X5
0054	M4X6
0057	M4X4
0033	M3X5
0031	2.9X6.5
0034	2.9X13.0
0089	M3X10
0093	M3X15
0095	M3X19
0097	M3X22
0099	M3X30
0081	M4X16
0083	M4X35
0085	M5X16

NO.	SIZE
0015	M2
0017	M3
0019	M3
0021	M4
0041	M2X8
0043	M2X10
0045	M2X14
0047	M2X16
0061	M3X8
0063	M3X10
0065	M3X12
0067	M3X14
0069	M3X16
0091	M3X16
0071	M3X18
0073	M3X20
0075	M3X25
0077	M3X30
0079	M3X35

M1:1