World Wide Web Model Helicopter

Phil Noel

The Canadian Connection

Continuing on the same theme as we did in the January issue, where we looked at the R/C helicopter's main rotor head from a consumers point of view, we will now move down the mainshaft (mainmast in some areas of this world) *(Ed: ... and in other worlds?)* and look at the part of the control system from the swashplate to the seesaw/flybar. As in part one, we are again looking for a system that flies well for as long as possible before developing any play/slop from everyday use. If everything stays 'tight', we like it. If it is easy to maintain and repair, we like it. If it can be configured to be stable and predictable in the hover while remaining responsive, predictable and quick upstairs, we like it. If it stays within our budget, we like it even more.

The design/manufacturing and marketing considerations discussed last time apply here also. We must always remember that we are trying to purchase the best that our respective budgets can afford. The beginner, whose budget only allows the purchase of an 'entry level' model, is better to get the one that best suits his/her requirements/budget and to start practicing right away. Getting in practice time on a lesser machine will do you far more good than getting no practice, as would result from one saving for the purchase of the 'top of the line' model the experts are flying. The sooner you start flying, the sooner you will learn how to do so (obvious is it not?).

The more experienced flyer that is looking to purchase something better than the entry level model he/she has trained on is best to go as good as they can possibly get. In this case they may be better off to keep practicing on what they have until they can afford the one they really want. In this case the no compromise approach may be the best one.

This month we will basically be looking at the systems and their components that one finds on the mainshaft that mix all the collective and cyclic commands - the seesaw/flybar system, the washout system and the swashplate. There are basically two systems used in our current crop of R/C helicopter for collective/cyclic control - the fixed swashplate and the moving/floating swashplate. From the average consumers point of view, I think we must accept the fact that both can perform equally well. Consequently we will be more concerned with crash

Photo #1

Photo #2

Photo #3

Photo #4

Photo #5

#1 - Plastic Hirobo Shuttle X swashplate with molded ball joints, and plastic center ball.

#2 - Bottom of the Shuttle X swashplate with the plastic center ball removed, showing the outer ring bearings and the seating from which they work loose.

#3 - Plastic Kalt Enforcer / Space Baron swashplate with metal ball joints and hard steel center ball.

#4 - Bottom of swashplate from photo #3. Note how the outer bearing is held in place by the lower "lip" molding.

#5 - ARK 0400-011 Shuttle / Hawk Metal swashplate with metal ball joints and hard steel center ball. Note the additional bronze bushing on the inner ring between the steel center ball and the inner ring and the machined cutouts to keep it as light as possible.

http://www.lance.co.uk/w3mh

resistance and the related costs, and the ease of maintenance and the related costs. First let's take a general look at the swashplates that apply to both systems, where we find three basic types:

a) the all plastic units with plastic outer ring, inner ring, centre ball and in some examples, even the ball joints are moulded onto the inner and outer rings.

b) the units with plastic inner and outer rings around a metal centre ball and with metal ball joints.

c) the all metal units with metal inner / outer rings, metal centre ball and metal ball joints.

The all plastic units are relatively light, very inexpensive to manufacture and will only be found on the lower priced entry level helicopters. When they are new, these units will be quite capable of performing their required duties on a thirty size machine. The molded plastic ball joints wear very quickly and should be replaced as soon as possible. The consequence of not doing so will not only result in loss of precision in control, but ultimately one of the ball links will work free of the ball joint and the resulting crash may prove costly in many ways. Not only will it cost you the time and money required for repairing the machine but it may have crashed into someone or something that could prove even more expensive. If there is sufficient 'meat' on the mounting area, the original molded units can be carefully cut away and replaced with metal units by drilling and tapping 2mm mounting holes for them in the appropriate places. As this should be done precisely and with care not to stress or crack the mounting area, I only recommend this procedure be attempted by the more proficient among us. The most common remedy at this point is to replace the swashplate. Replacing with the original unit will become expensive because this will have to be done on a very regular basis. The original part is usually about half of the price of a good upgrade metal unit. Therefore, I would suggest that the worn stock unit be replaced with an upgraded one the first time around. The metal upgrade will probably not only outlast this helicopter but a few more after it. The second type of swashplate takes a little longer before starting to show wear and will cost a little more to manufacture. As the ball joints are metal, one is left having with only having to replace the plastic ball links occasionally. Unfortunately, the plastic seats in which the bearing rings are seated will start to show compression wear and these rings will start to work loose. This will manifest itself in many ways. Initially it will seem like the collective is a little woolly. If allowed to be carried to it's extreme, it will show itself in the inability to set a consistent pitch curve and finally the dreaded blade flutter in the hover. As the inner plastic ring wears in its fit around the centre ball, one will be able to detect lateral movement in the swashplate. You will be able to hold onto the mainmast and while holding the swashplate level, be able to push it forward, backward, left and right against the mainshaft. This will contribute to a sloppy cyclic response and aggravate any pitching tendency that may be present in the design. The advantage of this type over the all plastic units is that you can fly with it for a lot longer before you will have to replace it.

When these swashplates start to show this wear it is time to replace with a metal upgrade as suggested for the all plastic unit. You will then be secure in the knowledge that you now have a component that will outlast the whole and never contribute to a woolly control system.

The third type is the all metal type as used in most 60's. They are the type we all upgrade to. Though they are the best type of swashplate, it is their cost that prohibits them from being included in entry level kits. To include these in 'entry level' kits would usually render the price of the kit outside of what would be considered 'entry' level.

The fixed swashplate systems (used in the older Schluter/Kalt machines and the more current Kalt Space Baron/Enforcers/30 Baron and TSK Five Star, et al) work the swashplate a lot less than do the floating swashplate systems (TSK Mystar Series, X-Cell, Futura, Hirobo, et al). The swashplate only has to rock left/right/fore/aft in order to transfer the cyclic commands. The collective pitch requirements are transferred separately, through an additional system, to the washout or other mixer. Though this may mean more flying before wear shows up in the swashplate, it also means that wear will show itself in the mixing system sooner. It's six of one and half

The fixed swashplate system of the Kalt Enforcer / Space Baron. Note the collective controls move the Washout up and down from a pin up the center of the mainshaft that is connected to the two control rods ride on the outside of the mainshaft and attach directly to the washout.

a dozen of the other. Consequently, I do not think the fixed or the floating swashplate system has any ‘wear’ advantage over the other.

Some fixed swashplate systems have hollow mainshafts with slots machined into them. The collective control rod runs up the centre of the shaft and is connected to the ‘mixer’ with a pin that rides in the slot. In some cases the slots remain open all the way to the top. In this example, the strength of the top of the shaft, the part of the shaft onto which the main rotor head is attached, is severely compromised. These hollow slotted shafts may be lighter but they are also much more costly to manufacture resulting in higher costs when replacement is required should they be bent in a crash.

The collective mechanism only from Photo #6. Note the long Center Control Rod and the two outer rods that come back and attach to the washout, and the complexity of the four mixing arms used.

Other fixed swashplate systems run two collective control rods up the side of the shaft in a more complex system. These are a bit of a fiddle to repair and have more parts that can be broken in a crash. I have always preferred the KIS principle - Keep It Simple. The floating swashplate system is the least complex of the two and that is its advantage. These are all basically CCPM (cyclic/collective pitch mixing) systems. Most are mixed mechanically by the servo control systems and some electronically by software in the radio or by an external electronic circuit. As most designs today are using this floating swashplate system, we will concentrate on it.

The swashplate is moved up and down for the collective pitch requirements and is rocked left/right/ fore/aft for the cyclic movements; in turn it transfers all these commands directly to the Washout and Seesaw mixers for coordinating the flybar (stabilizer bar) inputs and the swashplate inputs before reaching the mainblade pitch arms. (It sounds more complex than it really is.)

Both systems use the Washout and the Seesaw. The washout is the unit just above the swashplate

The ARK floating swashplate system on an upgraded Shuttle ZX. Note the swashplate is designed to move up and down the mainmast and the washout only has one mixing arm on each side.

that moves up and down the shaft with mixing arms on it and the seesaw is the unit through which the flybar is supported. It allows the flybar to ‘seesaw’ up and down and to rotate on its axis. After the swashplate, the next important unit is the washout hub. Here again are four basic designs. The all molded plastic, the molded plastic with a brass bush, the machined aluminium and the machined aluminium with a brass bush. The all molded plastic unit quickly compresses in an oval pattern parallel

The stock plastic washout hub from Shuttle and the ARK 5203-042 Machined Metal Washout Hub - note the bronze bush in the center to ride up and down on the mainmast and to take the mixing loads.

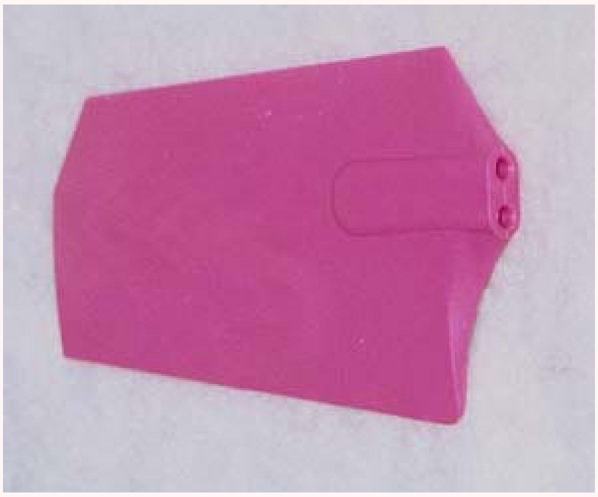
The stock Shuttle ZX plastic seesaw arms and the ARK metal units with machined bearing seats. The plastic unit accepts a flanged bearing on each side of it therefore it will take a long time before the bearing seats show any compression wear.

to the mixing arms. This allows the complete washout system to rock back and forth before transferring the inputs from the swashplate - oh no, dreaded control slop! The machined aluminium washout hubs suffer a similar fate, albeit, it takes a fair bit of use before it shows. The two units with bushes are the best, as it takes them a long time to show any wear. They will start showing wear in their guide pin slots long before showing any wear of consequence in the bushes.

The next on the list is the seesaw. For precise control we want the flybar to be able to seesaw up and down on its pivot without any undesired movement fore and aft. We also want it to be as free as possible to rotate in its mounting with as little play as possible. Experience has proven to me that bearings in all of these areas are much smoother even though the movements are only 45 degrees or so, but they also do not damage as easily in a crash as do the less expensive bushes.

The underside of the stock Shuttle ZX seesaw unit. Note the thickness of the bearing seat area of the control arms allowing for a bearing on each side with spacers between them. A well designed plastic arm.

Now let us consider the flybar stabilization system. To cover this subject in detail, a complete article dedicated to the complexity of the flybar/stabilizer system would have to be written. For the purpose of this article we will keep it simple. The heavier the flybar paddles, the more they will act as a stabilizer. The larger the flybar paddles the more they can control the flybar and the more they 'fly' the system. Consequently, for the novice, a large, heavy, fat, airfoil shaped flybar paddle is a plus. The more experienced will want an ever lighter unit. A thin, large and light paddle will be very quick. The further forward the flybar enters the paddle, the less sensitive will be the system. Any existing system can be 'tuned' somewhat by the addition of special weights on each side of the flybar. These are then moved in and out along the length of the flybar. The further out they are the more they stabilize the system. When shopping do not forget to check the flybar paddles to see if they are of a type that would suit you or whether you would have to add the tuning weights.



K&S of Japan 30 size dual rate flybar paddle #328. Note the two mounting holes. The forward hole is for less cyclic speed relative to the rear mounting. This thin, light (16 gram) paddle can radically change the cyclic rate of your heli. Taming it with adjustable flybar weights may be desirable on some head designs (Ed: Desirable! I'd say vital... :-)

Last are the control/mixing arms themselves. I have found that most helicopters today come with stiff enough plastic/composite control arms and bellcranks. Therefore I do not see that great an advantage in the metal, machined units. A sturdy ball bearinged plastic arm is almost as good as the machined metal units. The slight advantage that the machined metal unit may have are that their bearing seats are not as prone to deform in a crash and the after market units usually have a choice of ball joint mountings to fine tune to a particular response. For the average flyer, the fact that the arms or bellcranks have bearings rather than bushes is much more important than if they are made of metal or plastic.

The upgrade many flyers first purchase are these metal arms, probably because they are the most visible (the 'sizzle' we discussed in the January issue). In my humble opinion, they are the least important to the whole scheme of things. The swashplate, washout hub and seesaw (in that order) are much more due our serious consideration. Let us not forget that we are always shopping for the buy that would best satisfy our own personal tastes and requirements. To some, the hot purple anodized, machined aluminium washers on every capscrew gives him more pleasure than does a tighter washout hub. So for him the choice is one for sizzle. For the flyer who puts performance or longevity as the priority, he will look for a better washout hub. I am sure both flyers enjoy their respective helicopters equally, albeit for different reasons.

I hope all of this helps you in analyzing the advantages and benefits of the different choices in the control systems from the swashplate to the rotor head that are present in the current helicopter kits available for general consumption.

In the May issue I intend to examine the tail rotor systems and in July the servo tray/power train/ mainframe areas will be scrutinized. By then a general overview of the state of the market can be presented that will hopefully tie it all together.

Phil Noel

phil_noel@bc.sympatico.ca

The standard Hirobo Shuttle ZX paddle. Note the weight in front of the mounting hole. This thick, 25 gram paddle works well for most type of flight.

An end view of the ZXX and K&S paddles. Note the differences in airfoil and thickness.

It's Springtime
in the
Northern
Hemisphere...