Morley Mk.3

JIM MORLEY DESCRIBES THE DESIGN AND DEVELOPMENT OF HIS LATEST PROJECT

IT WAS ABOUT three years ago that I began to heed the comments that my current R/C helicopter design the *Morley* Mk 2c was too difficult to make for many helicopter enthusiasts. I knew that it wasn't everybody who had the necessary basic engineering skill, or the time, or even the desire, to make the *Bell* 47 G format upon which the 2c was based.

What I thought was required was something in full kit form at a reasonable price and be a scale model helicopter as opposed to a radio controlled rotary winged aircraft.

Although there are others that come into the 'bubble and stick' category, the *Hughes* 300 was for me by far and away the most attractive. An outline was drawn and the mechanical details mused upon.

Experimental models

Two years ago the first complete design was finished. I was so excited by the simplicity and general appeal that much sleep was lost until it existed as a model. But, it didn't work!

Well to be fair to my designer's hat it did work but obviously wasn't the winner that I thought it would be, for reasons which I spent a lot of time and effort trying to cure.

From **Fig. 1** you will see that the transmission includes three belts. With the width of the *Hughes* 300 it was possible to get a sufficient reduction from the engine to the rotor mast in one, with the engine pointing upwards in front of a monster pulley combined with clutch and cooling fan. I considered, on paper, that it would be acceptable to start the engine through the door with a belt. I was a little dubious of a clutch at mast speed and wondered how big the fan blades would need to be to provide cooling. I should add that the primary reduction was to be with a new style belt tooth form and I ran into patent problems here but that is another story. Funnily enough running the clutch at mast speed worked perfectly and the fan was reasonable, there was lots of room, but the duct would have presented production problems.

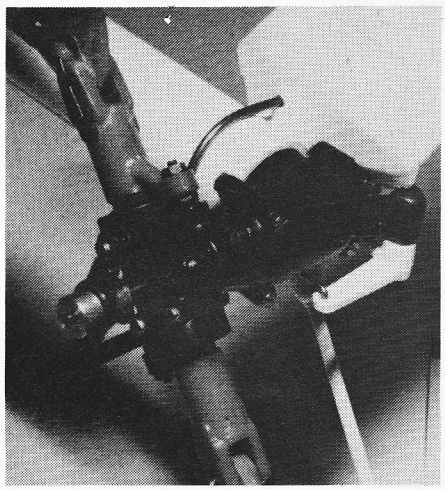
The tail drive, was in theory, the clever part, even though I don't like the idea of gearing up again to reach tail rotor speed, I arranged a large pulley on the mast to a small idler pulley under the tail boom at the point of stay joints. Another little pulley on the idler shaft was inside the boom, driving an identical belt running rearwards twisted through 90° to the tail rotor. So simple, but the pulleys were a bit small and the belt jumped after a while. Also, the external belt at the front of the boom was 'stretched' every time you picked the model up in the obvious way.

The second 'experimental' was bigger. The idea was to get all the tail belt drive inside the tail boom and use conventional belts. It was possibly too big for a 40 and it looked gangly. I had arranged angled idlers on the chassis to funnel the belt into the boom tube, see photo.

This system demanded an impossibly long belt, but nearly suitable ones existed and were tried. I was disappointed at the amount of power absorbed by this transmission and concluded that the belt was rubbing against itself and the boom tube sides. An attempt was made to improve it by gearing it down from a second pulley on the engine instead of up from the rotor mast speed. It was getting untidy.

Perhaps the first 'thrilling' experimental was as good as it could be. Certainly everything I did seemed to make it less desirable. Eventually I concluded that I was trying to be too revolutionary and scrapped the lot to begin again. That was one year ago.

Right: in the air, the MkIII is a fairly convincing Hughes 300. Below right: tail gearbox unit comes away as a complete unit by undoing the 'U' bolt. Typical of ease of replacement.



The Mk 3 prototype

At this stage I knew what I wanted from the appearance point of view and was convinced enough to commission a mould for the principle external parts. The cavities were being made while I designed and started tooling for the 'works' of a more conventional machine using components already proven on the 2c.

By early summer the external parts cavities were completed and by a knife and fork method some components were extricated for a display model. Then the firm making the moulds went out of business.

Needless to say you can't do a production mould without all the bolsters, ejector pins, etc., so this resulted in a much bigger load settling onto my shoulders and caused something of a delay. Eventually however the prototype became a 'production prototype' as the various bits and pieces were replaced by production parts for the new model.

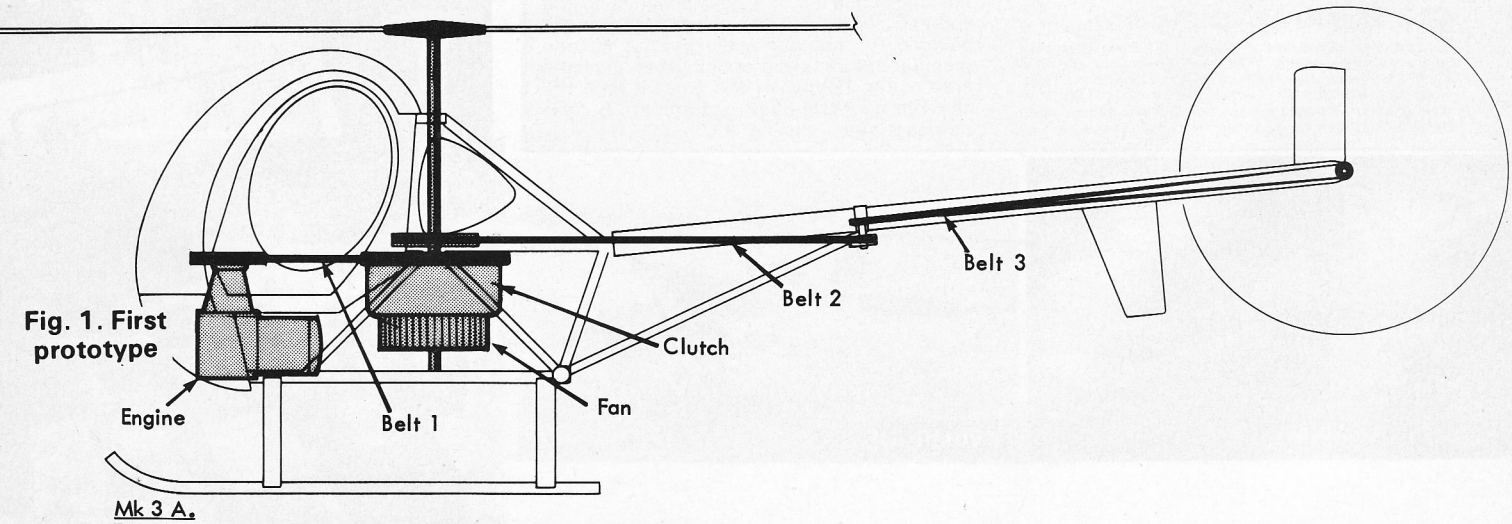
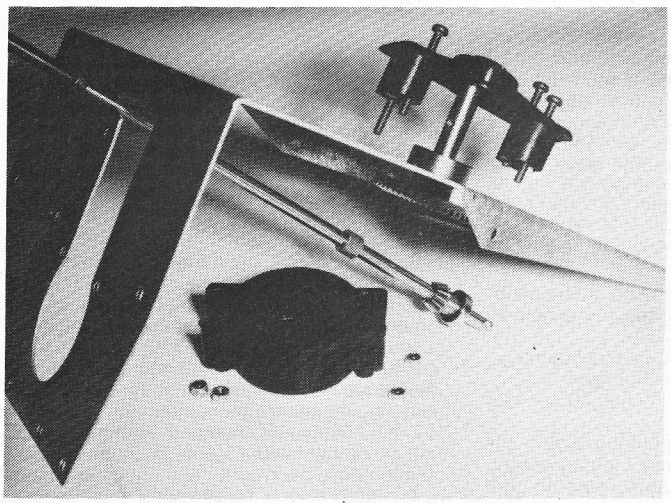


Fig. 1. First prototype

Mk 3 A.
First Experimental. Entire drive with three belts. Nearly worked

Hughes 300



Left: main frame with drive shaft, gears and gearbox cover. Note that a simple change of pinion position would allow reversal of rotor direction. Below: realistic rear shot of complete model.

There were a few delivery problems, and a few technical ones; the silliest concerning the attractive shock absorbing undercarriage.

The original design had the bellows on top of the shock absorber struts made of synthetic 'rubber' and for all the considered loads this worked fine. In moderate loads it deflected and gave a useful resilience. In accidental loads it 'gave' completely and could be put back together without any spares being required. Ideal you would think, and so did I until I started showing the model around when it became obvious that a lot of people managed to put a down load on the sides to look underneath. I hadn't thought of that, and the ball fitting at the top of the damper popped off far too easily and got very annoying. The modification to cure this entailed another moulding and resulted in most of the damping being lost, but now it's a good sturdy undercart.

Finally a new tail rotor gearbox was made to go straight into the tube, which incidentally is plastic made in the same moulds as electrical conduit, etc. This it was decided is amply strong enough to take the flight loads and, when broken, is ridiculously cheap to replace.

That last feature is the extreme of one of the principle design parameters of the model, namely that if an item is going to get broken, and tail booms would get broken even if made of titanium, then it must be easily replaced or mended. 'Easily' meaning in terms of both time and money.

The other principle design parameter was that it must have a pleasing scale appearance, especially in flight. We now have the new model.

The *Morley Mk. 3* then is a near 1/7th scale *Hughes* 300 for almost any 0.40cu. in. engine and four channel radio.

The engine sits upright pointing forward fitted with a standard silencer on cross-members in a rectangular frame forming the basis of the undercarriage. The same four bolts holding the triangulating stay ends, hold the skid legs in position while the dampers pop on with ball and socket joints for durability. These components are glass filled nylon for strength and the skids are light alloy tube. The engine is started from the front with a belt, and the first stage drive goes up in front of the fan duct to the gearbox input shaft carrying the clutch. Thus heavy items are aiding the C.G. problem and the clutch on the second stage is isolated from engine oil and rotational pulses from the I.C. engine.

The gearbox input shaft, on ball bearings, runs under the steel crownwheel and carrying the pinion in an enclosed gearcase. It is interesting to note that the pinion could be placed differently to change rotor direction. The shaft continues through a universal ball joint for the tail drive. Undo three screws and a servo link and the tail boom comes off complete!

The radio gear can all be placed in the cabin and remains reasonably unobtrusive allowing scale detail and a pilot to be built in. Control connections can be interaction free, and very positive, to the swash plate, all links having ball fittings for quality.

The cabin sides and tanks are ambidextrous, being the same on left and right and are moulded with scale detail. The doors, from the clear canopy moulding, can be made to open but the whole comes off with four screws, anyway.

Drive and tail control, as stated before, is by piano wire shaft running in brass tubing supported at the stay joining point and at the dagger fin position. A second universal ball joint on the tail gearbox allows this unit to be removed by slackening a horseshoe clamp holding the tail plane and tail skid. Positive location is by a pin through the boom tube. As tail rotor control is slightly more critical on this model with a short boom, the ballrace hub is supplied as standard. The tail gearbox is very rigid with a ballrace behind each steel mitre bevel. The tail rotor has tough hollow moulded blades on a drag hinge.

The collective pitch main rotor head needs no explanation, being the now well-tried Advanced Technology Morley head available for some 1½ years. It is so called because of the use of the flexibility of modern materials for the necessary movements in flaps and drag, being the most responsive 'all Hiller' system head so far.

Critics of the model pounce on the extensive use of plastic even though it has a light alloy chassis, and the use of adhesives at structural points. I consider this old fashioned, it is following full-size practice. The trick is to use the right plastic and to use the adhesive correctly. In sheer loading an adhesive can be 100% satisfactory, the trouble comes when you have 'peel'.

It has been a most satisfying and interesting design exercise, though pretty demanding. Initially kits will be supplied with yellow and white mouldings with black undercarriage parts.

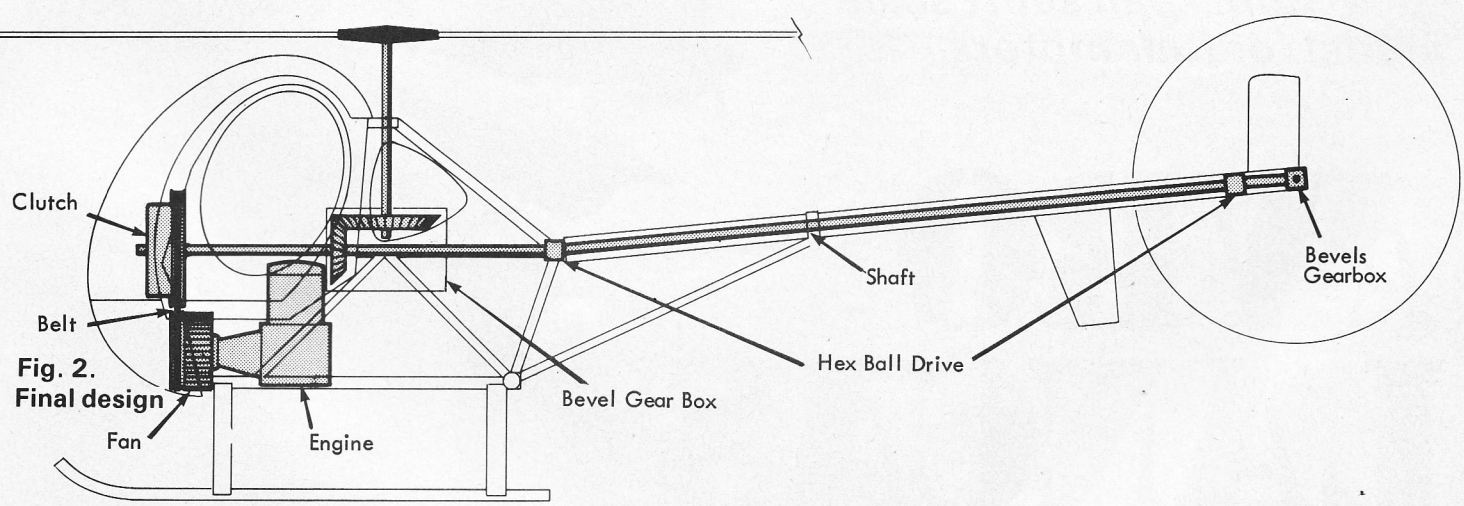


Fig. 2. Final design

Final Mk 3 has engine upright pointing forward. Belt first stage drive to bevel gearbox and shaft drive to tail.