

# GEARED UP

Mike Rainbird talks you through the transmission options available for 4x4 Cossie owners.



## MIKE RAINBIRD

Regular *Fast Ford* contributor, Mike has been involved with the fast Ford scene since the early '90s after he bought and subsequently modified a 2wd Sapphire Cosworth. One of the quickest and most notorious road-going Cosworths of the time, it was written off in 2002, after which Mike sourced a (now-equally infamous) Escort Cosworth that he still owns. Constant testing and development of all aspects of this car means that Mike now has unrivalled knowledge of modifying the Sierra and Escort Cosworths for road and track-day use.

In 1999 Mike set up R&B Motorsport, originally as a small company helping friends source parts for their cars. The company has grown through word-of-mouth and now specialises in track day upgrades (wheels, brakes and suspension parts) for Fords and other performance marques.

Stewart Sanderson returns next month

**STU** is taking time off to recover from his honeymoon (something was mentioned about a worn big-end, although I'm not really sure if this was car related or not!), so Simon asked if I would fill his shoes for a month. Given that transmission upgrades seem to be popular at the moment (no doubt due to the ever increasing power outputs that are putting a huge strain on these and breaking them), I thought that I would expand on one of my previous articles where I explained the reasons for choosing my transmission. This time I'll be giving you some choices that a 4x4 Cossie owner has for differing budgets.

Firstly, we need to expand on some terminology that you'll hear when gearboxes are talked about, and this is to do with the cut of the gears. The most common is helical-cut gears (where the teeth are cut at an angle), and is used in most standard road cars, and contrary to popular belief, is actually the strongest gear design! This is because at any one time, a helical gear-set will have around 1.5 teeth engaged. Unfortunately, it isn't as simple as that though, and the reason it is not popular in motorsport is that the helical-cut gears try to push themselves away from each other in the same direction as the shafts they run on. This means the requirement for all road gearboxes to have thrust bearings on each end of the shafts to take the load of the shafts trying to escape out the far end of the gearbox casing!

All that lateral effort is power being wasted and so a lot of racing teams use straight-cut gears to minimise this power loss through the gearbox, as well as reduce the side loadings induced on the transmission case. In fact, when the power is increased sufficiently, these side loadings experienced

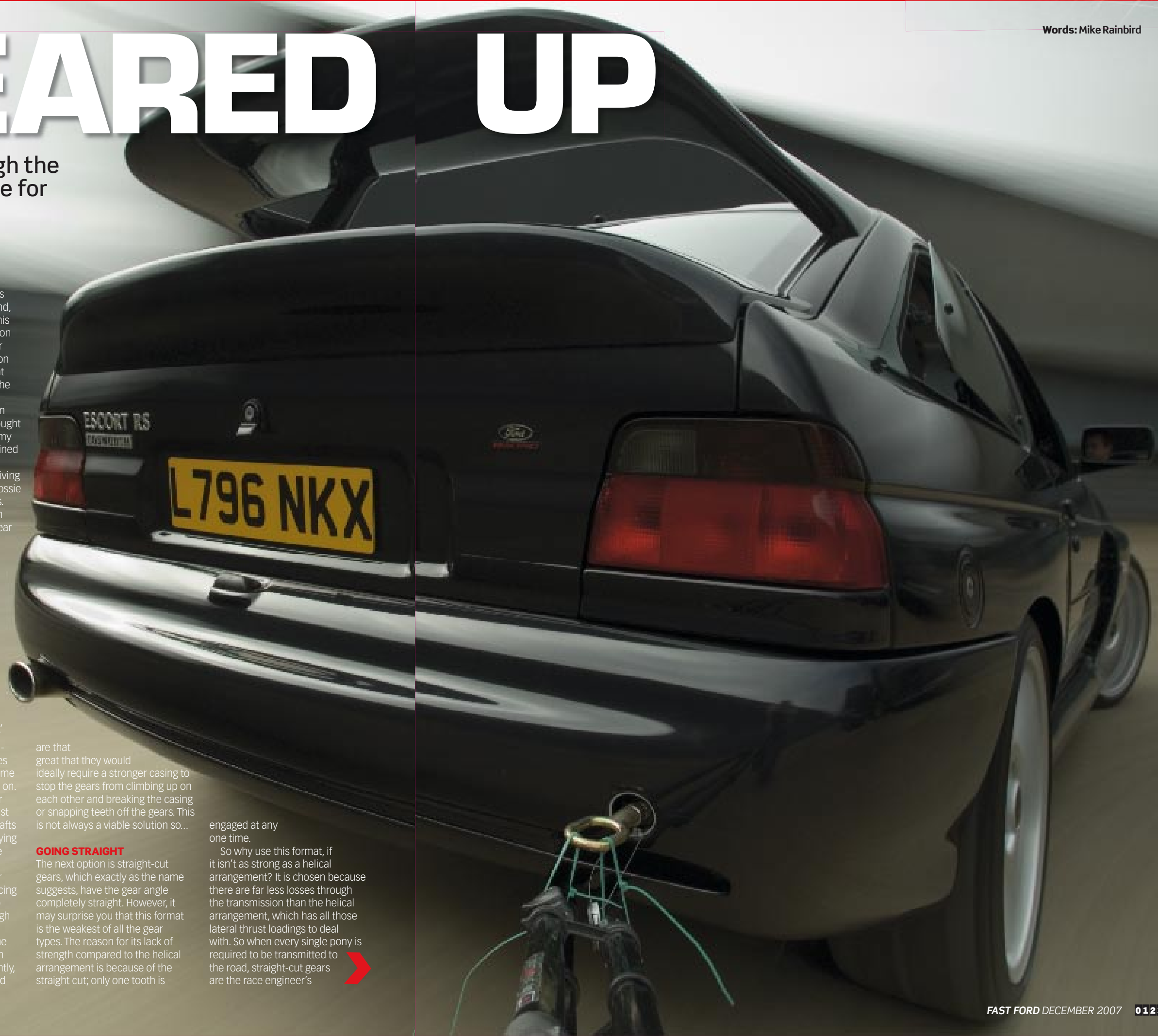
are that great that they would ideally require a stronger casing to stop the gears from climbing up on each other and breaking the casing or snapping teeth off the gears. This is not always a viable solution so...

### GOING STRAIGHT

The next option is straight-cut gears, which exactly as the name suggests, have the gear angle completely straight. However, it may surprise you that this format is the weakest of all the gear types. The reason for its lack of strength compared to the helical arrangement is because of the straight cut; only one tooth is

engaged at any one time.

So why use this format, if it isn't as strong as a helical arrangement? It is chosen because there are far less losses through the transmission than the helical arrangement, which has all those lateral thrust loadings to deal with. So when every single pony is required to be transmitted to the road, straight-cut gears are the race engineer's





choice. It also has the benefit of reducing the loadings that the casing has to contain, along with being far easier to manufacture.

The way the strength is regained over conventionally-cut gears is to use superior metals (often with a high chrome content to make the gears harder), along with heat treatments that do the same. Additionally, the teeth are often made physically bigger, to enable them to deal with the shearing forces that high power exerts on them.

Finally, you have the semi-helical (or semi-straight cut) gears. The cut of these is much shallower than the full helical cut, and so these fall between the strength of the full helical arrangement, but without the same amount of lateral forces being generated as the fully helical gears, which is effectively as good as you can get in an attempt to have the best of both worlds; as much strength as possible, with as little power loss as possible. Call it a halfway house between the two.

#### IN SYNC

Synchro and dog engagement refer to the way that the gears are selected and then connected to the shaft. All the forward gears are on a shaft and when in neutral, spin on bearings. The gearlever connects to a fork that pushes a sliding ring that is geared to a hub that is permanently geared to the same shaft. When you pull or push the lever, the ring engages teeth (not the same ones that engage the layshaft, but other teeth on the side at a 90-degree angle) on the spinning gear and they connect the gear to the ring to the hub to the shaft and the car will move.



Check out the size difference between OS Giken gears (right) with the (stripped!) MT75 items!



Big-tooth gearset has been shot-peened for strength, too

When you engage the spinning gear it needs to start spinning at the same rate as the hub or it makes a 'graunching' noise. Synchromesh is the way that a brake (synchro) starts engaging the hub and in turn, starts spinning the gear at the same speed so that the gears will mesh without noise (a worn synchro (brake) can be beaten and gear 'crunching' noise results).

Dog engagement uses a coarser type of tooth (like six or eight on a gear) with larger voids between them so that the teeth will drop in far more easily. So once the gears are spinning, the dog teeth drop in far easier due to their larger size. Close-ratio gears are also a help as the rotational spinning speed differences between each gear is less, making selection easier. The

downside is that dog rings clonk into gear noisily at slow speeds and also allow you to select any gear at any speed. Therefore, first gear could actually be selected at three-figure speeds!

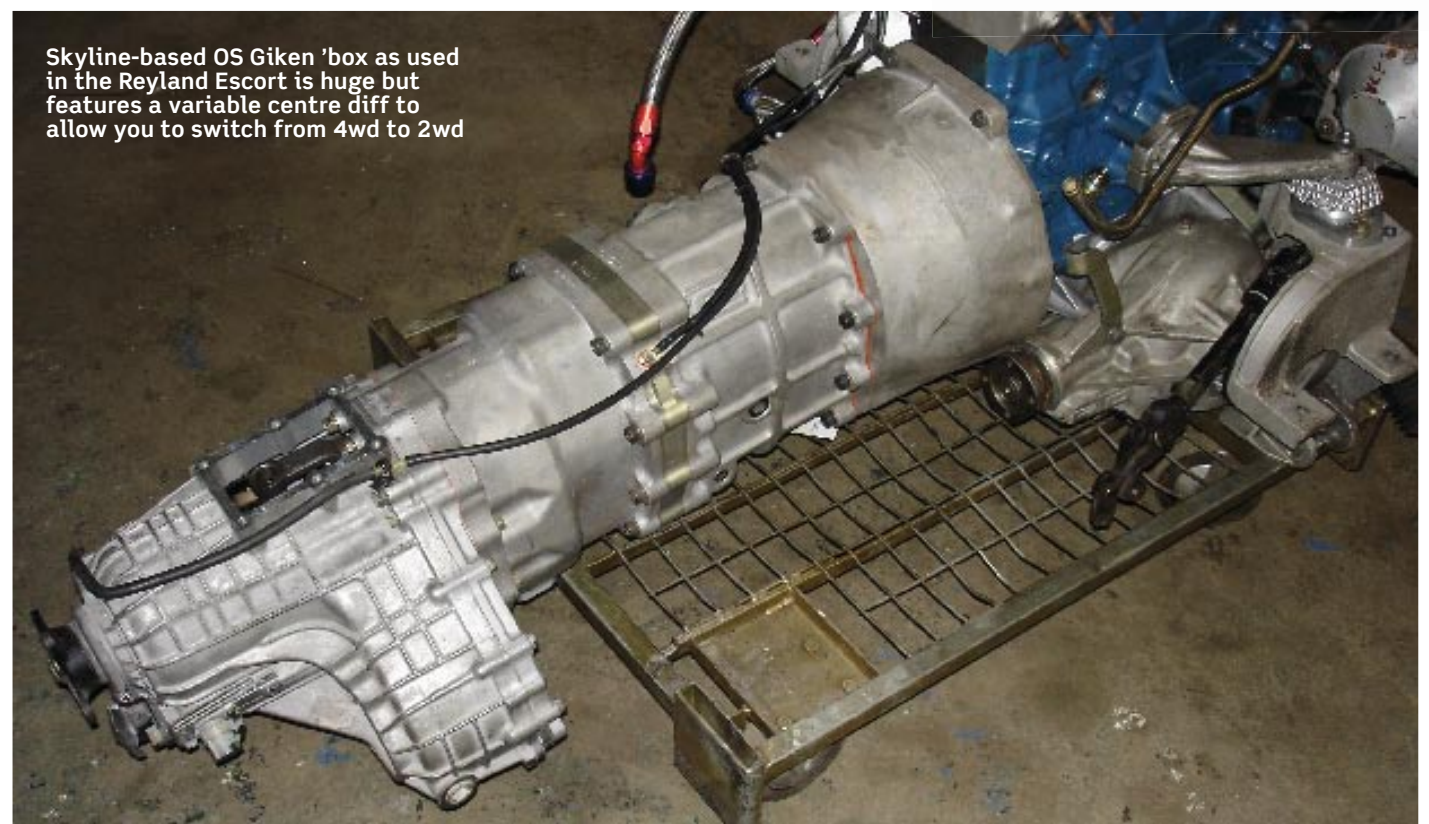
#### OLD GEAR

Unfortunately, the MT75 was designed around the time of the Ark, so its gearchange is slow and agricultural to say the least. Where modern gearboxes have two-piece synchro rings, the MT75 is just a simple one-piece arrangement. Therefore, when changing gear, it is imperative that you don't try and rush the change, or you will beat the synchro and end up burring the edges off the rings, which will mean that every change will be accompanied by a horrible crunch.

With first gear being on the main shaft and connected back-to-back with fourth gear, it is particularly strong and so very rarely fails. Unfortunately, if it does, then this is one of the ever-increasing parts from Ford that are 'no longer serviced' (a term any Cosworth owner is more than familiar with). Fortunately, Bara Motorsport does an uprated first gear that is readily available.

Normally, the first components to break in the standard gearbox are second or third gears, with third being the weakest. This is for a couple of reasons. Firstly, the gears/teeth are particularly puny, and secondly the stresses already mentioned that go with the helical cut of the gears. This pair of gears are on the small secondary shaft and therefore when the transfer of torque takes place from the primary to secondary shafts, the helical gears try and force themselves apart as they turn creating thrust forces against the end bearings.

Due to their spindly nature, any increase in torque above the 350 lbf. ft mark will wear them down and allow the gears to move further and further apart. Finally, the teeth just break off and obviously once one breaks it creates a horrible chain reaction as lumps of metal get stuck in the gears. Fourth gear is a 1:1 ratio straight through the gearbox and thus does not use any gears within the 'box, so other than bearing failure taking out the teeth, this is pretty resilient. Fifth gear also rarely fails due to the fact that the accelerative torque loadings being transmitted to the road is now greatly decreased compared to a lower gear and the rotational speed mismatch (for engagement



Skyline-based OS Giken 'box as used in the Reyland Escort is huge but features a variable centre diff to allow you to switch from 4wd to 2wd

purposes) is not so drastically different between fourth and fifth.

#### AVAILABILITY

Now, what is available for your car and at what budget level? The first level would be to strip the gearbox down and have it fully rebuilt with all new bearings, with the gears being shot-peened and micro-polished.

Shot-peening is where metal ball bearings are blasted at the gears and this relieves tensile stress of the surface of the metal that builds up in the grinding process, and replaces them with beneficial compressive stresses.

The micro-polishing process is done to selectively remove any high points on the metal surfaces giving the surface a bright finish, and ensuring an even metal-to-metal contact of as much surface area as possible. All of this should extend the life of the gears by around 15 per cent. However, be aware that it doesn't increase the strength of the gears by any significant amount, so don't expect miracles!

In my opinion, this should be done on any 4x4 Cossie running up to the limit of greens. Combine this with a strong magnet to pull any metal debris out of the oil and regular transmission oil changes and you should have a nice quiet, positive changing gearbox. Cost of this is around £600, which includes all new bearings and synchro rings.

#### NEXT STEP

The next upgrade is from Pete Doughty (DPE), which is available

in two versions, the first of which just replaces the second and third gears with much stronger (better quality/heat-treated/bigger-toothed gears, which are straight-cut items. The next stage is the same as the first, but includes an uprated main input shaft for additional strength (which prevents flex — a gearbox's nemesis). The cost of the former is around £1800 and the latter £2200, but both require you to send your gearbox to Pete for modification.



Swedish-made Fixit gearkit features semi-helical, close-ratio gears. Made from quality steel, they're strong, too

With the uprated main input shaft, it does make the gearbox very noisy in every gear bar fourth (direct-drive), as this is also straight-cut.

The next step up the financial scale is the Fixit gearkit from Sweden. This replaces all the Ford parts barring first gear and the main

shaft, which due to their inherent strength, don't break unless subjected to severe launching.

These gears are semi-helical for strength and are much stronger (better quality steel) and use larger teeth for further improvement again over standard. Not only that, but Bjorn at Fixit has concentrated on putting the ratios closer together to help the poor first to second gear change.

Fortunately, if you want a completely bullet proof gearbox (but not the noise of a fully straight-cut gear set), then it is possible to use the Bara Motorsport uprated first gear and main shaft, which would add another £1457 to the bill. Unfortunately, the production of the Fixit gear kits are pretty sporadic, and so obtaining these can prove problematical at the moment.

However, a new name on the scene for MT75 gear kits that has been mentioned earlier is Bara Motorsport, which has produced a big-tooth, fully straight-cut gearkit to meet the supply demands that the Swedes have been unable to keep up with. The increased strength over the original gearbox has come from combining racing gear tooth geometry and the introduction of a better material and heat treatment of all parts. Bara has also had the foresight to do uprated first gears and main shafts to produce a gear kit that only relies on the Ford synchro rings and bearings, thus making it as close to bullet proof as you can get. Price for the kit is £3114 for the gears alone, with



an additional £1457 for the first gear and main shaft. Again, you have the additional cost of around £600 to have this installed in your casing as per the Fixit gearkit detailed earlier.

Unfortunately, like all the MT75 gear kits, it still has the slow gear-change that is associated with the one-piece synchro rings, and none of these gear kits offer any improvement on the speed of the gearchange. Fortunately, Bara has had the foresight to also address this issue, and coming soon will be a dog engagement option for this gearkit, which will enable the driver to exploit the performance of the car to a greater extent.

This kit, like the strong synchromesh version can be fitted in the original MT75 gearbox casings without modification and will enable extremely rapid changes that 4x4 Cossie owners have always missed out on. Obviously on a road car, it will feel very agricultural compared to a synchromesh arrangement, but then you have to accept that you can't always have your cake and eat it!

## SIX SPEED

Next up the budget scale is the R&D six-speed gearbox, which has straight-cut gears and dog engagement. This gearbox again uses much larger gears to increase their strength over the standard MT75 arrangement and with dog engagement allows super-fast changes. You can even choose from a range of ratios, suitable for rallying and circuit use alike. Unfortunately, there seems to be a power limit of around 500 bhp to these before there's an issue with reliability. However, some of this can be attributed to ham-fisted drivers, as this gearbox is used by a number of competitors in the Ford Saloon

Championship to great effect. The cost for the complete built gearbox is around £5500, which includes a purpose-built casing as well.

The next jump is quite drastic and is actually around double the cost of the previous gearbox, but comes with an electronic centre diff controller to enable the power to be manually transferred from 100 per cent to the rear to full 50/50. Yep, you guessed it, the Skyline conversion as featured in Martin Hadland's car.

This uses a fully-sequential, semi-helical, dog-engagement 'box made by OS Giken, and comes with a custom-made bellhousing by Reyland to mate the gearbox to the engine, a gear indicator and the hydraulic pump from the Skyline, but with manual operation to split the power. Being dog-engagement, the 'box is quite agricultural and very noisy, but is rated to well over 1000 bhp, and that's in a 1600 kg Skyline, so a 1350 kg Escort/Sapphire should never bother it!

## RALLY DAYS

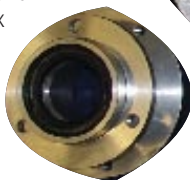
Beyond that is the FFD gearbox that was designed for Ford to meet its rallying requirements in the days when the Escort was a formidable weapon. This is available in both six and seven-speed straight-cut dog engagement through Bara Motorsport, weighing in at a similar price to the Reyland Skyline conversion in normal H-pattern selection or a hefty £15,000 in

sequential format. It uses a fixed power split, but can be purchased in either 50/50 or 63/37 with a variety of different ratios to suit forest or tarmac events. It is very strong, but in seven-speed format, the dog rings have had to be reduced in size to allow the fitment of the seven gears, which means that these can wear out very quickly if mistreated, so the six-speed is your best bet for really high-power applications.

So there you have it, the majority of choices available, and I haven't even been able to mention options for 2wd Cossies or expand on the equally-important aspect that the diffs play and the various options to suit. That will have to be another time.



Custom Reyland bellhousing allows use of Skyline/OS Giken gearbox



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## NEXT MONTH

The top 10 most common problems found with RS Turbos, and how to cure them.

FFD gearbox is available in six or seven-speed, H-pattern or sequential, and was used in the works Escort Cosworths and WRCS

