How do you mate an engine and gearbox that were never designed to go together if there isn't a kit to do it? Simon Goldsworthy investigates

Adaptor plates

Words and pictures by Simon Goldsworthy

Most engines offer no end of tuning possibilities, often with a bit of professional machining and plenty of DIY spannering. But gearboxes tend to be less adaptable. Sometimes a change of ratios is possible by careful trawling of the manufacturer's parts bin, but often the standard items will simply be overwhelmed by a modified engine.

And that's when the idea of using a stronger and better gearbox from another car altogether starts to make financial sense, as well as promising the most effective use of all that new power.

There are cost-effective adaptor kits available for many of the most popular combinations. It's worth shopping around to see what is already available for your car because, although in theory just about any combination of engine and gearbox can be made to work together, the reality is that the extra time and machining needed to make it happen could soon exceed the cost of buying a different box in the first place.

Having said that, some people may face very real issues (such as available space, desired ratios and sheer bloody-mindedness) that make them pioneer a new route.

Adaptor plates can also save you a wad of readies over buying a custom-made bellhousing. TVR make a nice cast alloy bellhousing to mate Rover's V8 to a Borg Warner T5 box from a Cosworth Sierra, but it retails for several hundred pounds. Mike Broad and Marcus Bennett at Magnum Engineering in Warwick (01926 642122, www.magnum-engineering.com) have been completing other people's unfinished projects as well as mating Rover V8 engines to Ford gearboxes in the company's own design of Cobra replica for years.

They also sell an adaptor plate and modified bellhousing to do the job for £200, so we visited Mike at the workshop to find out how it is done.

The first rule is to try and use the bellhousing from the engine, rather than the gearbox. The side of the housing that mates to the engine is both bigger and more complicated than the gearbox end, and fabricating an adaptor plate for it is correspondingly more difficult.

The second rule is to use a bellhousing that has a round hole (or register) to take the gearbox. That's because you obviously want the gearbox mainshaft and engine crankshaft to be perfectly aligned (first signs of misalignment will usually be the box jumping out of direct-drive fourth on the over-run). If the bellhousing has a round register, you simply need to open this out or sleeve it down to suit the box, and you will know that it is as central as when it left the factory.

Altering an irregular shaped hole requires much more work as it will need perfectly-placed dowels to locate the box centrally.

This is where experience can save you considerable time. Probably the most popular gearbox options are the Type 9 from Ford (Sierra, 2.8 Capri etc), basically a five-speed Cortina box which squeezes the extra ratio into a nice slim casing, and the stronger T5 (Mustang, Cosworth Sierra). Being Fords, they

Two Golden Rules

No 1: try to use the bellhousing from the engine you're using, not the one from the gearbox.

No 2: Where ever possible use a bellhousing that uses a round hole to locate the gearbox.

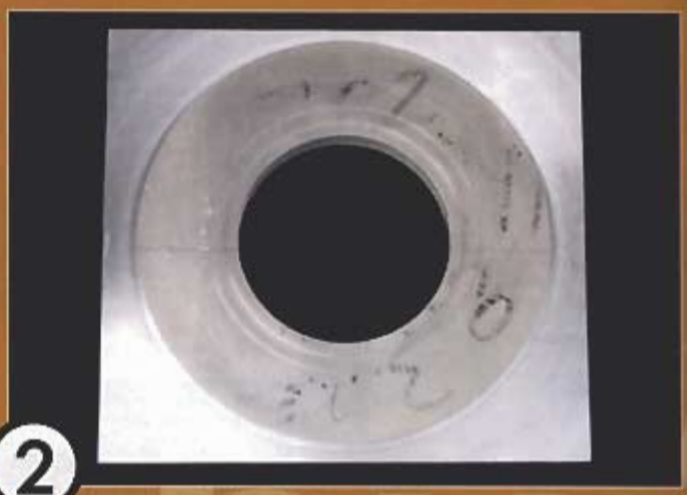
Below: Metro clutch slave cylinder has handy mountings.

Bottom: Concentric slave cylinders for Ford Type-9 and T5.

Step by step

Making your own adaptor plates

1 You don't need any particularly fancy material for the adaptor plate. Magnum have gone up to 3in thick in the past with ordinary aluminium. You could use steel but it's obviously a lot heavier.



2 Here, the plate has been machined out to take a Borg Warner T5 gearbox (Sierra Cosworth), while a lip on one side locates in the existing hole in the bellhousing of the Rover V8 we're mating it to.

are both straightforward and take a round register. But the bellhousing on the back of a later Rover V8 is a real bastard to adapt as the five-speed Rover box is located by dowels and the opening is an irregular shape.

Fortunately the bellhousing on an automatic Rover is a direct bolt-on to the engine and has a round register on the back. Even then there are two distinct sizes of automatic bellhousings used by Rover: the shallow one used on the P6 is ideal for the T5 box, while the in longer housing from an SD1 is the one you need for the Type 9.

That's why it pays to ask around before starting work and not limiting yourself to using whatever parts happen to be lying around in your garage.

If for whatever reason you're pioneering a new combination, the next rough-and-ready check that it will work is to place the bellhousing engine-side down on a flat surface and stand the gearbox on end as far as it will mate with the housing. You then need to measure how far the gearbox input shaft will protrude into the bellhousing.

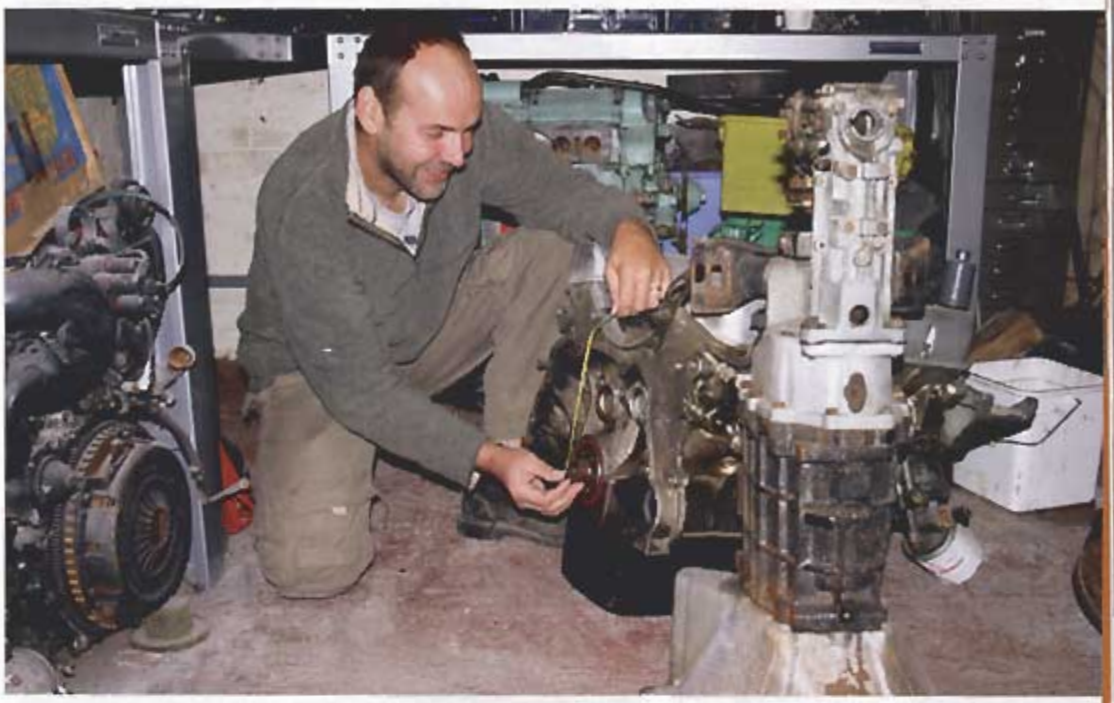
If you're lucky, it will be longer than you need to reach the crank. The amount by which it's too long is then the thickness of adaptor plate you need to bring things back into position, with 1/2in being the minimum needed to provide enough metal to take a tapped thread.

But if it is too short, then you may have problems. To bring it into position you may be able to squeeze the adaptor plate inside the bellhousing, effectively counter-sinking the gearbox into the bellhousing and shortening its length this way. But you will need a spacious housing and a very slim gearbox to have any chance of this working, and enough room for the clutch release arm and bearing.

More likely, you'll need to cut and shut the bellhousing, with the consequent risk of heat distortion and inaccuracies even if your welding skills can cope with cast aluminium. In such cases, it could be better to investigate the possibilities of fitting the donor engine and its gearbox as a unit and making the car fit around them.

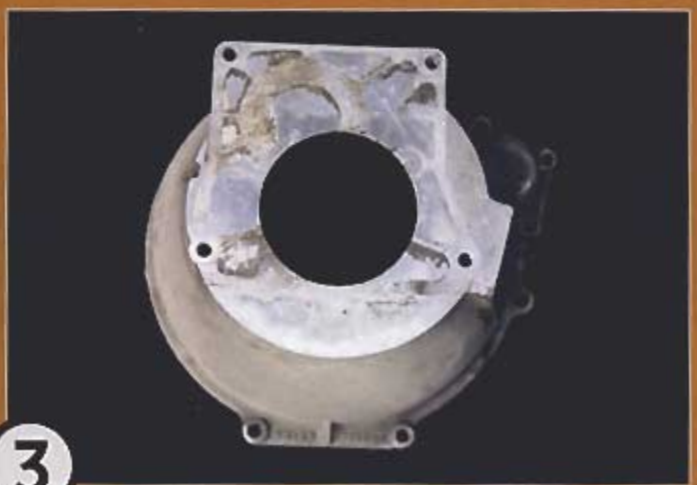
In the unlikely event of the input shaft being exactly the right length, you need to hope that there's enough metal on the bellhousing to re-drill it around the register to take the bolt pattern of the gearbox. If there isn't, you'll need an adaptor plate, and that will make the input shaft too short.

At least most crankshafts have a large enough opening in the end that once you get the positions sorted, a machine shop should be able to knock up a spigot bush for around £10 that will fit in the crank but still hold the input shaft snugly

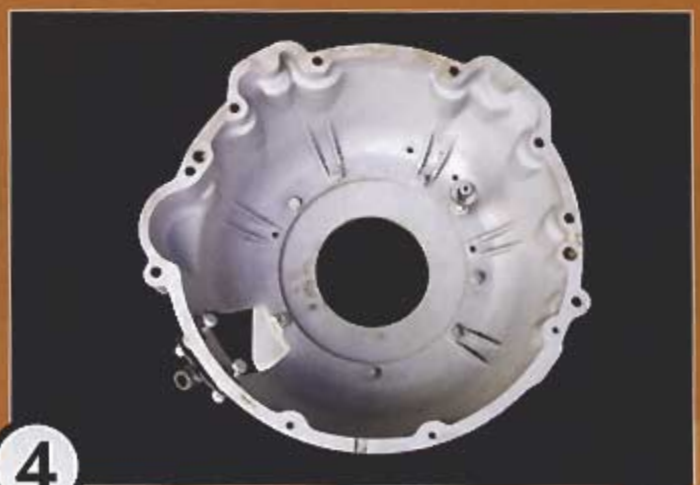


Top: **Rover V8 is a popular engine for gearbox conversions**

Above: **Master cylinders come in different bore sizes.**



3 By working from the Rover V8 bellhousing original round registers, you can be sure that when it is bolted to the adaptor plate, the gearbox will be central. This is a Rover V8 auto bellhousing.



4 This bell housing has been cut to take cable operation, although with this method it can be more difficult to balance pedal travel and pressure. This is more easily achieved using hydraulics.

in position.

Assuming you've sourced an appropriate bellhousing and gearbox and done your measurements, the next step is to get an adaptor plate made up. As long as you're working with round registers, you don't need a detailed template for this.

You simply need to tell the machine shop what thickness of plate you need, what diameter hole the gearbox will fit and what diameter lip you need to locate the plate in the bellhousing. A rough drawing to indicate how much metal needs to be left around the hole is then all the machine shop will need to provide a plate that will fit tightly in the bellhousing and hold the gearbox centrally.

When you get this plate home, you can then cut and shape the outer edges so that it's wide enough to accept the bolts you need, but not so wide that it compromises ground clearance or creates other packaging problems in the gearbox tunnel.

Then clamp the plate to the bellhousing and break out a decent set of drill bits. Drill through the bellhousing bolt holes to mark their positions on the plate: start off by using a bit the same size as the required holes, as this will start a hole that is perfectly centred. You can then switch to a smaller bit to drill pilot holes before opening them to the final size, which should take 7/16in or 12mm bolts as a minimum.

That will have the plate ready to bolt to the bellhousing, and the next step is to drill the holes for the gearbox. If you have the bellhousing that came with the box, then you can use that as a jig for locating the holes. Alternatively, a scrap gearbox casing is ideal. Failing either of those, you'll need to make a card pattern from the end of the box (a scrap casing makes a useful jig).

Top: **Keep adaptor plates flush so that they don't affect ground clearance.**

Above: **Custom clutch plate centres can be fitted for around £35.**

Alternatively you can make up a metal template, or even one out of MDF or cardboard: the bolt holes merely clamp the box to the adaptor plate, while the job of locating it centrally is done by the central bore.

Either way, make sure you mark on the adaptor plate where the top of the bellhousing sits and then match this up to the gearbox. Most likely you'll want the box to be vertical too, although you can rotate it slightly to move the position of where the gearstick enters the cabin.

With the drilled adaptor plate and both gearbox and bellhousing in one place, you can then figure out the best way of bolting them together. It doesn't make any real difference to the finished installation whether you use studs, bolts or countersunk machine screws, the decision usually coming down to how much access you have for the spanner. But you do want to use either Nyloc nuts or spring washers, because you can guarantee they'll be hidden away and you don't want them working loose.

The next step is to get a flywheel and clutch that will work with the engine and box you've chosen. It obviously makes things easier (and so saves you money) if you can use the items that came with the engine. In this respect, Rover and Ford help the process by both using the same inch/23 splines for gearbox and clutch (one inch diameter and 23 splines), although American T5 boxes have 10 splines.

If you're working with two incompatible items, you can get a clutch made up to suit. Simply take both clutches along to a specialist such as Clutch Distributors in Burton on Trent (01922 720029) and they'll mate the boss of one with the friction plate of the other. It's not as expensive as you might think either, at around £30-40 a pop.

If the need arises, you can have a billet flywheel made to mate a non-standard clutch to an engine for between £100-200, so long as an appropriate ring gear is available. A cheaper option could be to have your existing flywheel re-drilled to take a non-standard clutch cover.

But with any changes, make sure the balance of the engine is not upset, particularly if one of the

Step by step

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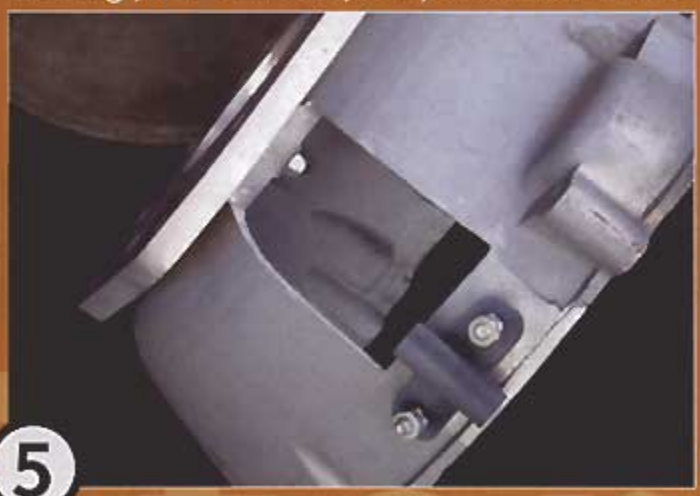
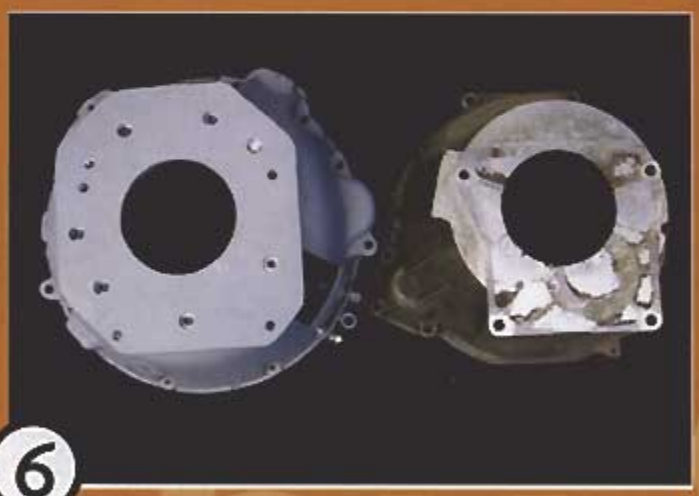


5 This small bracket is designed to hold a cable for clutch actuation. It's made from a piece of steel plate with a tube welded to it and simply bolts to the alloy bellhousing. Use Loctite on threads.



6 You need enough metal in the adaptor plate to copy the gearbox mounting holes. This picture shows the pattern on the Borg Warner T5 (aluminium, left) and the Ford T9 (iron, right).

flywheels contains balance weights.

The other bit of the clutch that will need modification is the release mechanism. If you're using the release bearing that came with the engine, you might have to enlarge or sleeve the hole in its centre before it will fit the release bearing carrier in the box.

If you're mixing and matching parts, you need to make sure the bearing has the correct profile for the clutch diaphragm fingers: straight fingers require a radiused edge to the bearing while curly fingers need a flat bearing.

You can cut a hole for the actuation lever on any side of the bellhousing, so look carefully to see where the most room is – many specialists put it in the top to make it easier to squeeze the box between chassis members. A lot of kit cars use the cable-operated pedal box from a Sierra or one from a Marina. The Marina one in particular is a pretty crap design (there's a surprise!) its short pedals able to cope with a weedy clutch but unfeasibly heavy when asked to cope with 400bhp. You really do need to match pedal length and actuation arm leverage to get the feel right, but any major changes here can leave you with too much pedal travel.

A better option is to go hydraulic. That way, changing the bore of the master cylinder can change the amount of pressure needed on the pedal and still keep travel within reasonable bounds. At the other end, an early Metro slave cylinder is ideal because it's cheap, compact and has two seats cast onto it to make it an easy bolt-on job. It also has enough travel to operate the biggest US clutch, despite its humble origins. An equally cheap alternative is the Rover SD1 slave.

When deciding whether to go cable or hydraulic, bear in mind that a cable-operated arm must pivot on the opposite side of the bellhousing to a hydraulically-operated one. This might influence your design, although Rally Design (01795 531871) do market a hydraulic slave cylinder that actually pulls instead of pushes.

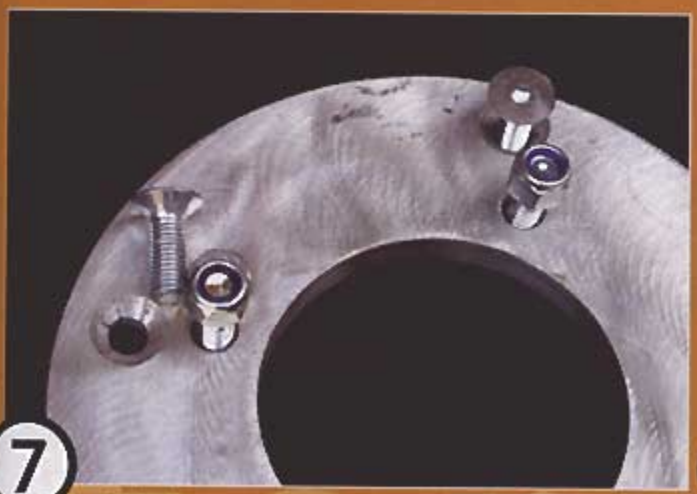
Whatever route you take, once you have everything bolted together, don't forget to bleed a hydraulic system properly and to make sure there's some free play left at the pushrod.

Using an adjustable pushrod will make this job much easier, so you should consider including one in the original build sheet. ◆

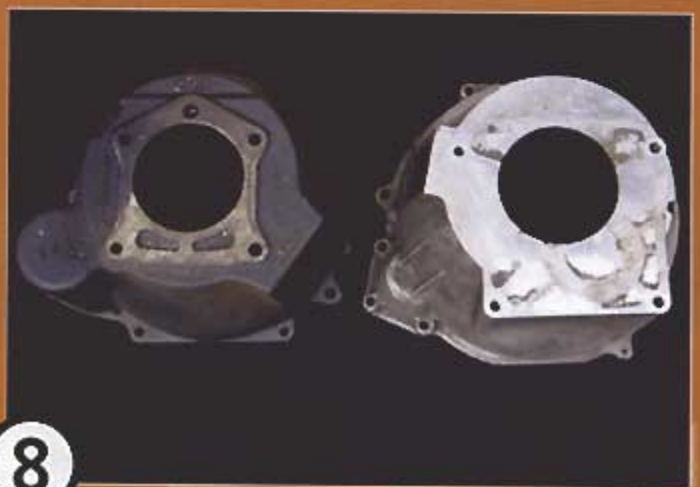
Here's one a PPC reader prepared earlier...

A home made bellhousing in the early stages of production. More next month.

Clearly it's easier to work with a conventional combination of engine and box. Equally clearly, you lot are anything but conventional. So how about mating a 3-litre V6 from a FWD Alfa 164 to a RWD Ford Type 9 box? To do that, one reader made his own bellhousing from scratch. He made a cracking job too – details of how he did it next month.



7 Studs, bolts or machine screws are all possible fixings. This adaptor plate for a Ford 3-litre box has made use of countersunk screws, which make for a flush-fitting and neat finished job.



8 The cast iron bellhousing on the left is from a Ford Type 9 (Sierra, Capri). The alloy one on the right is the Rover V8 automatic bellhousing that's been modified to accept a Borg Warner T5 box.