Europa Series 2 (1969)

Conversion to Renault NG 5 speed gearbox with cable actuated gear change

NB: this is theoretical – it shifts very precisely without too much effort in the garage with no oil in the box but the car is many months away from actually being on the road.

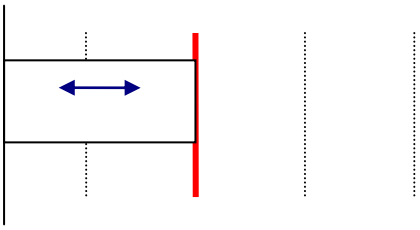
I can supply other photos or an improved description of any part of this if anyone is interested

Parts sourcing

1. NG gearbox (ex. Banks) with gear shift actuator rod on the lower rear right hand side.
2. NG gearbox mounts (ex. Banks) with custom plates and rear cross member.
3. 2x push / pull cables Vetus / Teleflex marine style (Type 33C) with 5 mm rod ends – custom made to length via Hindle Controls in the UK (about £15.00 each and only a few days turnaround). Final was 1.8m and 1.83m in length to allow for smooth routing – started with 2.0m for rough setup, final length determined by position of the outer cable brackets (clamps) at each end. (www.hindle.co.uk). Stock sizes 1.75m, 2.0m, 2.25m etc.
4. The bell-cranks, lever and bushes from the original S2 rod linkage although I later purchased new bushes and the centre brass pivot sleeve (the cross tee assembly).
5. Toyota MR2 – Mk2 shifter assembly including mounting bracket (steel) - ebay
6. Toyota MR2 – Mk3 shifter assembly including mounting (nylon) and cables – ebay
7. 1.5 mm plate steel (and some brazing) to make the shifter bracket (to mount to the tunnel)
8. 3mm strip used to make the cable mounting brackets
9. A mixture of ¼ inch (mounting shifter to tunnel) and 8mm (bellcrank etc) bolts, nuts and washers and probably some weird sizes I do not remember.
10. 8mm internally threaded rod (to make the bell crank arms) – this was purchased as linkage rod from McGill Motorsport (UK ebay) - they do these with RH / LH threads to make turnbuckles (£4 each – I do not have a lathe so this was a quick and easy solution).
11. Some off cuts of tubing and steel for brackets.
12. 8mm ball and socket joint (x1) and 8mm female rod ends (x2) from automotioncomponents.co.uk

Gearbox end actuator rod movement

Some measurements (in mm) at the gearbox actuator rod that were used to calculate leverages;



5^{th}	3^{rd} / 4^{th}	1^{st} / 2^{nd}	R	
19	24	28	35	(from casing)
-5	0	+5	+11	(from neutral)
Push	Neutral	Pull	Pull	

Shifter assembly

1. Initially I developed something using a VW Passat mechanism; the leverage was just enough to activate the gearbox but the shifter weights were too heavy and the shifter crank operated in the horizontal plane, restricting modification because of the limited width inside the S2 tunnel. A huge amount of custom work here and it all went in the bin.

2. The experiment proved the theory but a better donor was needed. An ebay search yielded a Mk2 and a Mk3 Toyota MR2 shifter assembly on offer at the same time (including the mountings and the Mk3 had cables). There appeared to be pro's and con's with both (from the photo's) so I bit the bullet and purchased both of them – with the experience below it may be possible to get just the specific parts but frankly buy both assemblies on ebay or from a dismantlers / breakers will be the easiest option.

3. The two Mk's of Toyota shifter work quite differently:

    a. Mk2 is a ball swivelling in a nylon cup within a metal housing BUT the cables pull off the lever above the ball joint, and the bell-crank operates above the mounting bracket – no good for the S2 as it needs to be below the bracket (i.e. inside the tunnel, not above it).

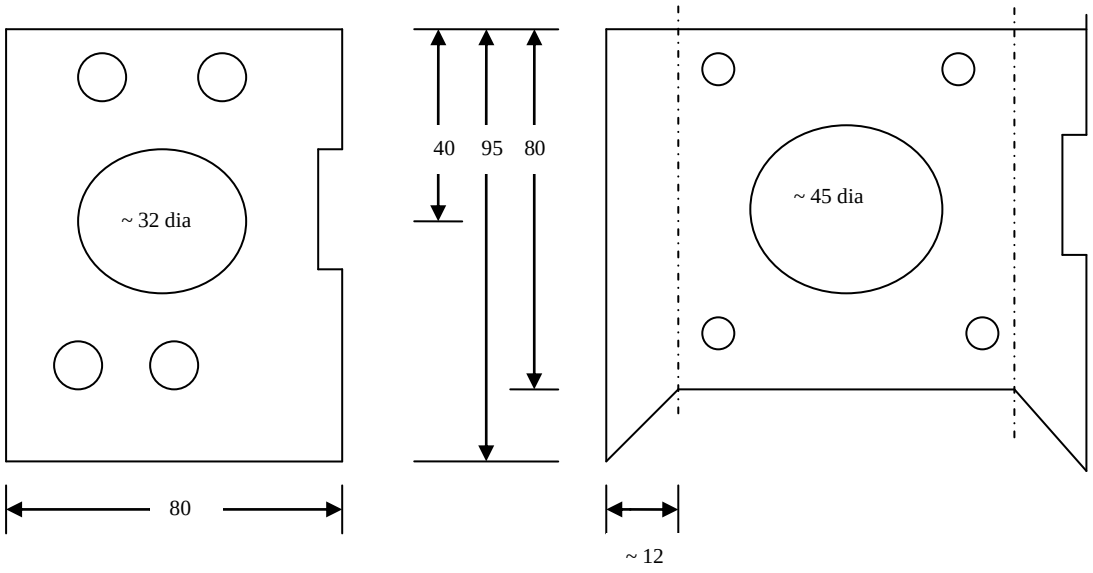
    b. Mk3 is extended below the ball swivel to activate the fore / aft cable and the bell crank (in / out cable) is also downwards BUT it is all nylon bracketry – not easily adapted.

    c. Parts from both were used as Mr. Toyota did not change the essential sizes of the ball joints and bushes and swivel pins and etc.

    d. The picture shows the <u>discards</u> from the Mk2 and Mk3 assemblies.

4. Shifter mount:
    a. Strip both shifter assemblies and make bracket from ~ 1.5mm plate:

Not to scale. Dimensions are approximate:



Lower

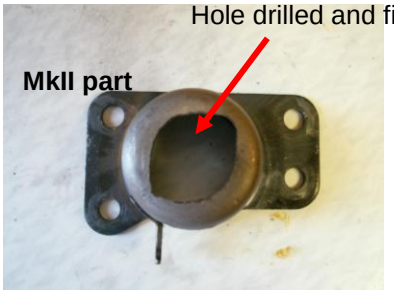
Upper with edges to fold down

b. Line up the Mk2 metal cup housing and drill holes to mount it (I brazed 8mm nuts on to act as captives) – this is the lower mount plate.

Finished mounting bracket

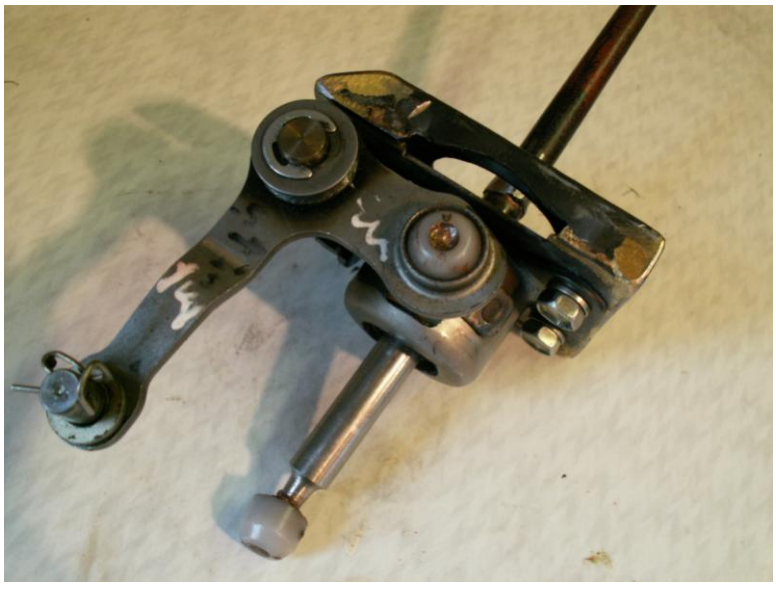
c. Drill a hole in the bottom of the Mk2 metal cup housing (to allow the Mk3 shifter to be mounted in the Mk2 cup and cup housing with the lever and joint passing through the bottom. I roughly lined up with the existing rubber washer on the bottom of the Mk2 cup housing then filed the hole in the metal cup housing to relief for 5th right and forwards and reverse left and back – this took a bit of experiment – which failed in test – stripped this out and relieved the entire area in the below picture so there was only a narrow lip to hold the ball and cup in: no restriction to lever travel at all in all directions from this cup or the mount bracket or the Lotus tunnel hole – you need it all especially in the fore / aft plane.

d. Insert the Mk3 shifter into the Mk2 nylon cup, replace the retaining clip and install in the modified Mk2 cup bracket (with a rubber washer thing in the bottom). Bolt this to the lower mount plate and at the same time include the Mk2 bell-crank pivot bracket.



e. Mount the Mk3 bell-crank (it is longer and faces down) using the MK2 pivot bolt, spring and circlip. I bent one of the spring arms slightly to ensure it lined up with the grooved stop on the mounting cup.

f. By moving the gear lever left to right the bell-crank push / pulls but at the top of the travel some metal needs removing from the mounting plate you cut in ‘a’ above – i.e. the bell-crank is proud of the mounting plate at the top of its travel.



g. This lot now needs to be bolted to the inside of the S2; problem is the top of the bell-crank movement comes proud of the square mount plate, and, on the underside centreline of the tunnel is a ridge – I did not want to remove any of that. Solution – a second plate with a hole in it, with the sides folded down 8 – 10 mm to spot braze (or whatever) onto the lower plate and again relief some for the bell-crank top travel on the right hand side.

h. Feed this into the tunnel (I had already enlarged the oval opening when messing with the first shifter assembly so it was very easy). Hold the gear lever in the centre and mark the location of the mounting holes. Again – I had already drilled mounting holes that were wider than existing and I used those to spread the load wide of the centre gear lever hole (which was also filed a bit to clear the new gear lever travel).

i. Remove, split the two plates again, captive nuts for the tunnel mounting bolts (1/4") and rejoin. I also plated the front opening between the top and bottom mount plates and some reinforcing of the rear gap – that may have been over engineering. The rear of the mounting assembly is shorter at the top compared to the bottom – this clears the chassis ridge at the rear.

j. I also cut the Toyota lever off 10 mm above its ball joint and welded the S2 lever to it. Everything above the tunnel is Lotus, meaning the lever, gaiter, knob and etc. will be original and look stock.

5. Shifter to cables:

a. In the Toyota application the cables have bespoke ends – essentially the stock Toyota flexi cables have a rod with a ring and plastic bush (for the bell-crank) and an alloy cup with a retaining spring for the ball joint on the end of the gear lever (for the forward and aft movement).

b. The bell crank one is easy – cut the thing off the cable leaving about 10 mm of rod. Drill a 6mm hole in a 30 – 40 mm length of 8 mm solid rod, insert the off-cut rod and braze them together. The other end is drilled (4.2 mm) and tapped to 5mm x 1.25 thread – therefore the Type 33C cable literally screws into the rod and has the right end on it to attach to the bell-crank. Replace the nylon centre bush and attach to the shifter using the original washers and retaining clip.

c. I tried the same approach for the alloy socket on the other cable but the alloy melted as the heat from the 6mm rod was too much during brazing! I made that one up by copying the alloy socket using part of the (waste) Mk2 bell-crank, and some 1.5mm plate and 3mm strip and the same idea with 8mm solid rod. Maybe cutting the ball off the end of the gear lever and changing its end would be easier but copying the alloy one with only basic hand tools and a brazing torch was fun (!?). The rod for that one was cut so the overall length of this one was ~ 80mm vs. the bell crank one at ~ 40 mm (when fitted the cables start at the same place (when viewed from above).

6. Cables

One cable runs down the middle, the other on the right hand side (in the tunnel). I drilled a hole in the end of the backbone to line up with the right hand position and grommeted this and the centre (existing gear linkage rod hole) to feed the cables through.

I cut some 1.5 mm angle to the width of the tunnel, put ends on it, drilled these through the tunnel then attached a tapped 4mm plate to the outside of the tunnel (body is off!) – I will relief some of the under felt and so these will not interfere with the body fit. The assembly was located by slotting it (10mm) to accept the cables at the point where they have a locating recess.

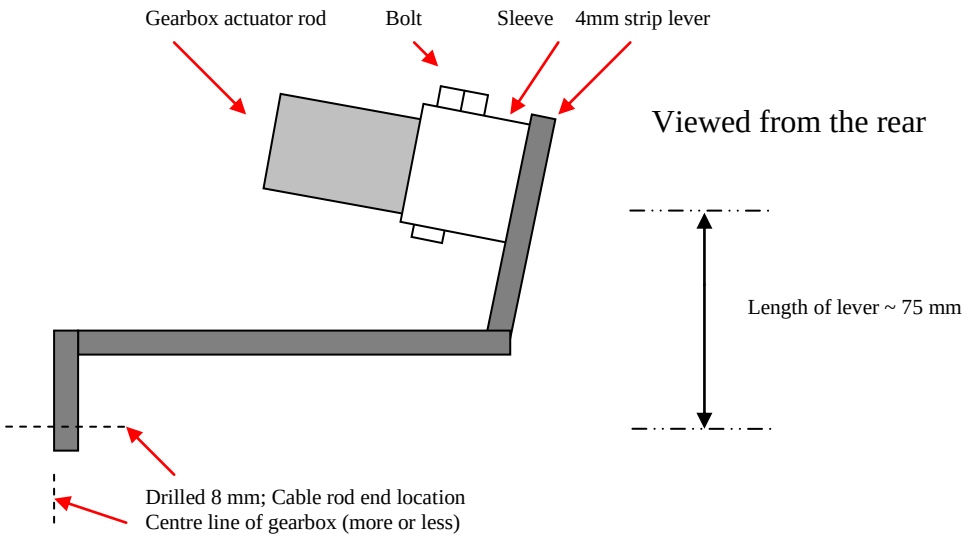
I then made a matching 3 mm strip with slots (6 mm slot) to capture them – the strip and angle bolt together. Outer cables are located.

I have routed the cables using rubber sleeved P-clips to keep it tidy with smooth gentle curves. One bracket comes off the chassis just in front of the motor (rhs) and both clip here to keep them clear of pulleys and belts, then the lower one routes downwards with another bracket off a sump mounting bolt. The upper cable is clipped to a bracket off the bell housing.

Gearbox actuation

1. I had a tube turned for me that sleeved over the gearbox actuator rod. By manually pressing the rod inwards (i.e. towards 5th gear) I was able to mark the maximum amount of sleeve over lap to the actuator rod (i.e. enough free actuator rod to allow the assembly to push in and engage 5th). I then drilled through both to ¼ inch to insert a bolt through to join the sleeve to the rod.

2. On the end of the sleeve I welded some strip (4mm – all I had at the time, I am sure 3mm would do) and bent this under the box and down – this became the lever arm for the forward / back action – note that the actuator rod angles downwards as it exits the gearbox.



3. An 8mm rod end was modified to step down from 8 mm internal thread to 5 mm to accept the 5mm external thread on the Type 33C cable;

   a. an 8 mm threaded brass rod screwed into it, drilled and tapped 5 mm

   b. Bolt the rod end to the lever with the cable screwed up 80% of its thread (allows some fine adjustment) and now the location of the cable outer can be determined. Somehow lock the gear lever in the vertical position otherwise there is a risk that everything is finalised and the gearlever is in the fully forward or back position with no-where to go.

   c. I routed the cable literally along the bottom of the gearbox and through the lower suspension control arm bracket (that bolts to the bottom of the gearbox on the S2) by modifying the bracket by drilling through the bracket and brazing in a tube about 2 inches long to act as a sleeve over the outer cable. A slotted clamp then bolts to the S2 suspension bracket and engages the groove in the outer cable to lock it in place.

4. Once the outer cable is located (captured) the gear lever can be activated forwards and backwards – some tweaking of the gearbox lever may be needed if it hits the gearbox going forward or the rear cross member going back but you pretty quickly have two gears (3rd and 4th) and if the cable is not kinked anywhere (nice gentle curves are required) then the action should be very positive and not need much force at all. If the cable is cornering too tight or the inner is not in line as it exits the outer it will bind.

5. Next is the gearbox end bell-crank to push / pull the actuator rod in / out of the gearbox.

   a. 

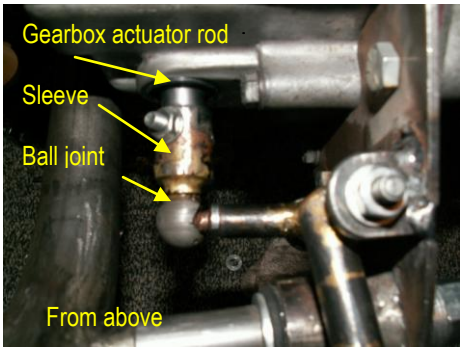
   Using a ball and socket joint (8 mm) the female end was cut down and brazed onto the lever / sleeve assembly lining up with the centre of the sleeve. The socket was grooved slightly to relief it so that there was a bit more swivel for when the lever was pushed forward or back.

   The idea is that the socket allows the sleeve / actuator to rotate fore and aft but the ball will push / pull the socket to move the actuator rod in and out of the gearbox as you move across the gate (R to 1st / 2nd to 3rd / 4th to 5th).

   b. Using the original S2 sleeved crank parts (centre rod with nylon end bushes, ~65mm long outer tube with the bits cut off it) to make a swivel.

c. A short length of tapped bar (McGill Motorsport link rod) was brazed to one end of the swivel and the ball joint attached to the sleeve – this resulted in a **~ 45mm** lower lever from the centreline of the swivel to the centre of the actuator rod.

d. This assembly was then mounted to the gearbox actuator and aligned on the gearbox mounting bracket on a slight angle so that swivel rod was at 90 degrees to the actuator rod (which is not horizontal). The top and bottom swivel mounting brackets were 4mm strip drilled and welded to the gearbox mounting bracket.



e. A longer rod was brazed at the top of the swivel at 90 degrees to the short lower one and horizontal to the floor (the picture to the left is an earlier version and appears to be greater than 90 degrees). This was made with link rod again and incorporated an adjustable end (for length adjustment) and an 8mm bolt to allow another modified 8mm rod end to be attached. This lever is **~ 75mm** (i.e. 75/45 or 1.66:1 leverage). Lengthening it will reduce the effort at the shifter but there is a point at which it will not travel far enough to push / pull the gearbox actuator enough to engage gears.

6. Cable attachment to the gearbox.

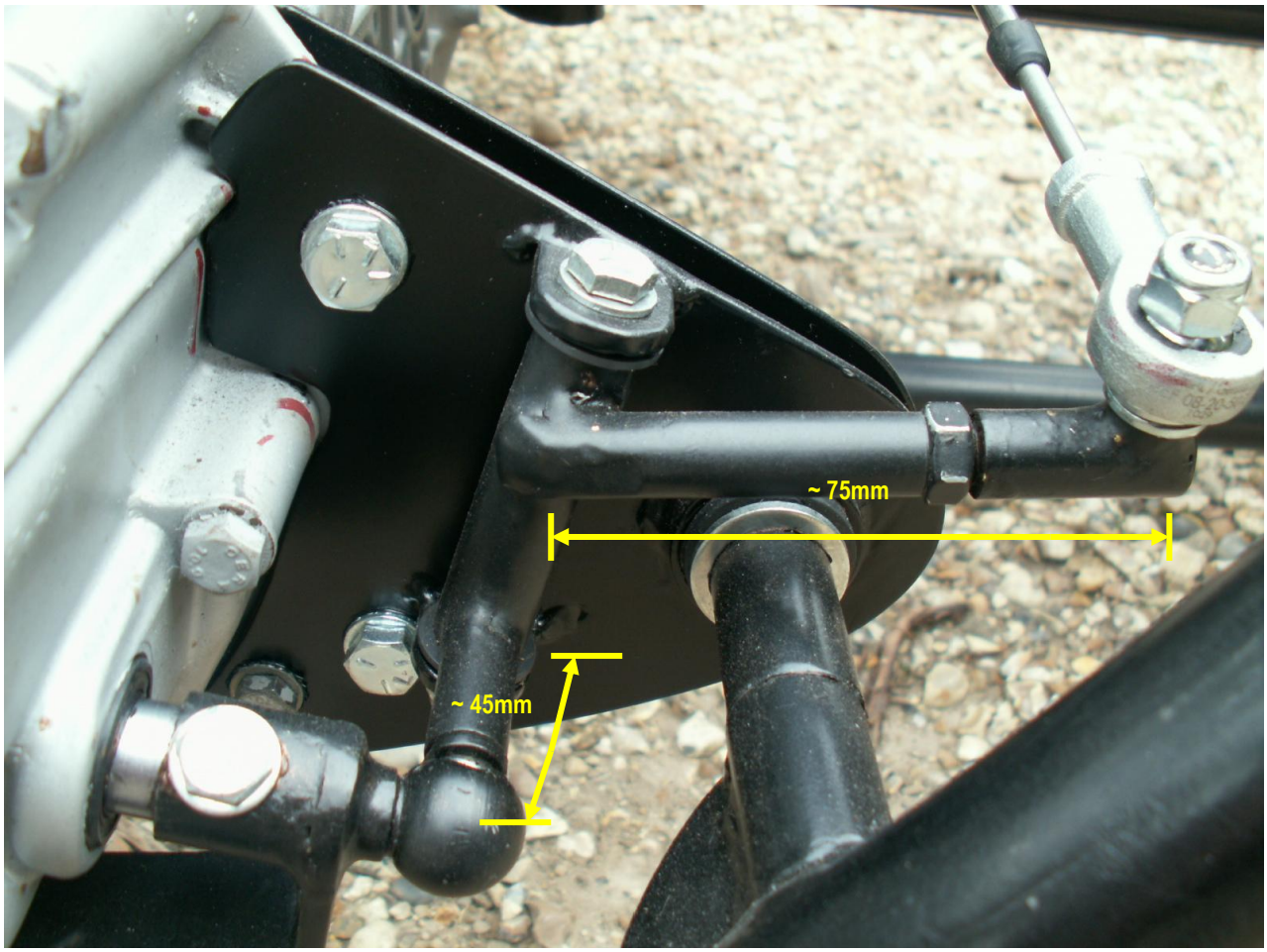
a. With the cable attached at the shifter end and mounted inside he tunnel; screw the cable end into the rod end attached to the gear box bell crank (check that the gearlever is held in the neutral position) then a nice smooth cable run can be made and the location of the cable clamp determined.

b. This was made using a saddle clamp (from Hindle for the Type 33C – it has a key that engages the cable outer groove) and this was screwed to a mount made using lightweight tubes triangulated from the gearbox using spare gearbox case threaded mounting holes (although the 10mm threads result in bolts that are a bit over the top for the loads involved).

c. Now, when you move the gear lever left and right the Toyota bell crank push / pulls the cable which then push / pulls the 8mm rod end that activates my gear box bell-crank to either push the gear box actuator rod in, or pull it out, via the 8mm ball joint.

d. Since these photos were taken the triangular gearbox mount (pic above) was remade (shorter and a bit higher to clear the drive shaft at full bump). However it is mounted the aim is for smooth cable routing with only straight lines or very gentle curves.

e. A friend who owned an Esprit V8 reckons that (static) my gear lever action (as I have a similar 5 speed box) is more positive and direct than the Esprit so I have high hopes for when the car is on the road



Bell crank assembly, attached to the gear box mounting bracket, viewed from the rear clearly showing the bespoke gearbox mount plate (2.5mm steel, sandwiching the gear box ears), the rod end and ball joint mechanism as described in the text and you can just make out the lever going under the box from the end of the actuator rod sleeve (for fore / aft movement) in the bottom left corner of the photo..