

# The manual transmission system



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In this report, I am going to compare and contrast the difference between Toyota 5 speed manual gearbox transmission and Toyota 5 speed automatic transmission system.

## **2. History of the transmission**

In 1894 Louis-Rene Panhard and Emile Levassor invented the modern transmission.

Today we still use the same concept since it was introduced. The concept is still the same that the crankshaft connects from the engine to the transmission shaft through clutch. The latter is mounted to gears which control and operate the transmission of the motion that is coming from the engine to the wheels. Few experiments have been done about type and numbers of gears but still until today the same concept is applied. To make it easier for the driver to control speed and with help of gears, synchromesh gears and a live rear axle were invented. Instead of having gears engage and disengage again from each other, a car transmission that had gears and continuous with each other was introduced, all the gears were moving and the dog clutch was designed in order to connect the gears that are caused to rotate by engine and move the wheels forward.

Different gears with different sizes are designed to increase or decrease the momentum of the vehicle. The most popular transmissions were 4 speed transmissions which its top gear (4th) had a ratio of 1: 1 while other gears had lower ratios. Then, engineers came with a 5th gear in which will increase the ratio by 1 between the engine rpm and the wheel rpm that is known as overdrive.

American inventors Harold Sinclair and Richard Spikes designed automatic transmission while German inventors invented the automatic transmission rudimentary design. While General Motors provided automatic transmission in all of their cars that were manufactured from 1938 and by the end of 1940s most of the car manufactures offered at least one transmission in their models. Electric cars also fitted with electric car transmission. Now the market for automatic transmission is huge and most cars are manufactured with it (Car transmission, 2006)

### **3. Automatic transmission system**

This is the type of transmission that is capable of changing the gear ratios automatically while the vehicle is moving without the need of the driver to manually change the gear using the gear stick. The main purpose of the transmission is to provide the following outcome:

Neutral - to keep the engine running without the gear, or moving the vehicle.

Lower gears - for taking off purpose and for operating in heavier situation.

Higher gears - for cruising, higher speed and lighter weight

Reverse gear - to move the vehicle backwards.

Transferring the driving torque to the required wheels (Crolla, D, 2009, p, 109)

The automatic transmission comes into two different types. The front wheel drives vehicles that are designed more compact than rear wheel drive vehicle's transmissions that are normally connected in the engine

compartment in which they are known as transaxle. Both of these types of transmission do the same job and same design of the planetary gear train.

The essential part for the front wheel drive transmission is differential, while the rear wheel drive transmission has externally mounted differential which is uses the drive shaft to link up with the transmission.

The automatic transmission system contains few major components. These are:

Planetary gear unit

Torque converter

Hydraulic control unit

Seals and gasket

Computer

Governor/ modulator

The above six components perform various duties in transmission as explained below (Toyota technical training).

### **Planetary gear unit:**

The purpose of planetary gear unit is to provide and changing different gear ratios. Generally, the planetary gear unit contains three major parts. These are ring gear, inner gear (sun gear) and planetary carrier that carries three or four gears which are between the inner gear and outer ring gear.

## **Planetary gear unit**

When one part of the planetary gear connects to the input shaft which leads to the engine, the second part is held still and the third part usually attached to the output shaft. It all depends on which part stays still, which one is the input or output because it will result in different gear ratios. Things such as brake bands, hydraulic clutch packs and one way clutches are used in the planetary gear to control the power flow. Every gear links up to a combination of clutch packs and brake bands being engaged or disengaged (Samarins. com)

## **Torque converter**

Is a fluid type coupling, that lets the engine to rotate freely without the help from the transmission, if the engine is running slowly, idling or on the stop traffic, there is a small amount of torque that is passed via torque converter, less pressure is also required on the brake pedal to keep the car stationary. Also when you put more pressure on the gas pedal, it speeds up and adds more fluid into the torque converter which causes the wheels to receive more torque.

The torque converter housing contains five major components. Pump is fixed to housing, turbine that is connected through output shaft to transmission, stator has output that is connected to fixed shaft in transmission, fluid and converter clutch. This housing is attached to the engine's flywheel and rotates and at any speed that the engine is spinning. The torque converter also has pumps that is made up of fins and are attached to the housing that uses the same speed as engine to turn.

Centrifugal type pump is used inside the torque converter, as it rotates it causes the fluid to be thrown outside and this action creates the vacuum that draws a lot of fluid in at the centre. Once the fluid arrives in the blades of the turbine, the transmission begins to rotate and this causes the car to move, the turbine's blades are curved and this makes the fluid that is coming from the outside to go into different way before it goes to the centre of the turbine, this changing of direction is the one that causes the turbine to spin. In other way we can put that both turbine and the fluid spin in different direction and this creates the force as an outcome. This fluid that exists from the turbine is usually moving into different direction as the pump and engine turn, because if the fluid hits the pump directly, it may cause the engine to waste power or slow it down and that is why there is a stator in the torque converter (Builders transmission and used car Inc.).

### **Hydraulic control unit:**

A transmission fluid is sent using the engine oil pump that controls the performance of the car clutches that helps the planetary gear sets to work smoothly.

### **Seals and gasket**

Their work is to support and maintain the right place of the engine oil and stop it from leaking outside.

### **Governor / Modulator**

This controls and monitors throttle position and the speed of the car to determine when to change the gears.

## **Computer**

This is the major unit that uses sensors to control all the activities such as engine speed, engine load, throttle position, brake pedal position etc.

(Carazoo, 2010)

## **4. Materials**

The materials that are used to build clutch or transmission have to resist heat, friction, durable, strong, hard and tough. These materials are organic, Kevlar, segmented Kevlar, hybrid carbon, ceramic and sintered iron (UUC Motorwerks, 2003)

## **5. Advantages of automatic transmission system**

The torque converter gives more engine torques and reduces the strain and the shock of the entire drive line. A lock up clutch is included in the latest automatic transmission, this helps in maximizing the fuel economy because of its direct mechanical linkage from the engine to the transmission. A vehicle with automatic transmission is very comfortable and easy to drive as the driver does not need to manually change the gear ratios.

Automatic transmission can also be powerful and strong because of the arrangement of the sun gear and ring gear, this increase the gear's contacts that reduces the gear's breakage and supplies more torque on big area (Rowe, R. 2010)

## **6. Disadvantages of automatic transmission**

Since the automatic transmission is made up of several components, the main setback can occur when single part breaks down working and this can cause a transmission to stop working, as a result maintaining or fixing it can

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be very expensive. Also the total speed of the vehicle is controlled by the computer that manages the transmission, and the driver can lose the acceleration beyond a certain speed.

Automatic transmission can overheat easily.

## **7. Manual transmission system**

This is the type of transmission in which the driver has to manually change the gear ratio setting by using the gear stick inside the car.

There are two types of manual transmissions. The constant mesh design and the sliding gear type. The sliding-gear type, no part is turning inside the transmission case except the main drive gear and cluster gear when the transmission is in neutral. In order to mesh the gears and apply engine power to move the vehicle, the driver pushes the clutch pedal and moves the shift knob, which shifts a linkage and forks to slide a gear along the main shaft that is connected straight above the cluster. Once the gears are meshed, the clutch pedal is released and the power from the engine is sent to the drive wheels. There can be different gears on the main shaft of different diameters and tooth counts, and the transmission shift linkage is designed so the driver has to unmesh one gear before being able to mesh another. With these older transmissions, gear clash is a problem because the gears are all rotating at different speed (Cook, M. 2009)

The 5 speed manual transmission gear box has a three plane arrangement order with reverse gear alongside fifth gear and uses a special fluid to operate. Moving forks are attached to three wide base rails that work in arranged bushing for less friction, these moving levers are connected

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together to the shifting cables. Every one of them uses different way with selected lever and this creates less shifting efforts for a driver, it also avoids to accidentally engaging the reverse gear from fifth because of the way it is designed to operate, it shifts the crossover lever into three to four gear without jamming or binding.

The shift knob is usually used to control the gear ratios. The forward gear ratios are synchronized using great capacity dual cone brass (1st and 2nd) and other gears are synchronized with paper friction materials which is more strong and clash resistant than brass. The input shaft uses paper materials synchronizers, by cutting rotating inertia it helps to reduce the shifting effort. A reverse engagement clash can be minimised by using a brake mechanism.

The needle roller bearings are fixed to reduce friction and extend gear life. The case itself is cast in only two pieces to reduce leak paths; structural ribs strengthen and harden the case to reduce noise and vibration with small or no extra weight. The case has good bending stiffness, offering a natural frequency above the exciting frequency of the engine at peak rpm (Massey, K. 2010)

## **8. Clutch system**

A manual transmission system will not function without a clutch. This is the mechanism that is used for transmitting rotation that can be engaged and disengaged. This is controlled by the driver who uses a special release mechanism to control the movement of the torque between them.

### **The clutch assembly**

A single disc clutch assembly contains four major parts:

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the rear face of the flywheel- a driving member

the clutch disc- the driven member

the pressure plate assembly-a driving member

the release mechanism-disengages and engages the clutch

(May, E. 2004. p, 250)

## **8. 1 Types of clutches**

Multidisc clutch that contain two or more disc are usually used in automatic transmission, motor cycles and heavy mechanical equipment. While the manual transmission is operated using a dry clutch and there is no lubrication between surfaces. The automatic transmission clutch operates wet, it is enclosed in the transmission case that is full of lubrication fluid.

Generally, in automatic transmission there is no clutch pedal and a gear shift  
(Roymech, 2010)

(Genta & Morello, 2009 p, 425)

There are so many different types of clutches such as cone clutches, wet clutches and dry clutches but the common one uses one or more friction discs that are pushed very tight together or against the fly wheel using a spring. A Clutch contains two rotating shafts, one is operated using pulley and the other one uses a different method, these two shafts are connected together by the clutch so that they can be locked together and rotating at the same time while it engages, or be decoupled and rotate at different speed while it disengages. The input shaft is used at the centre of the

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pressure to engage the splines of the friction disc hub. The clutch and flywheel assembly spinning as one unit when the engine is rotating. The flywheel is receiving the torque from the engine, uses the friction that is occurring from the clutch discs to the spline hub into the transmission. When the clutch pedal is moved, it manages and controls the movement of the torque between two units. The pressure plate can be retracted against the springs force and frees the disc from its clamping action by depressing the pedal. These two units and clamping force can be connected again by releasing the pedal once again.

This is a very important mechanism when:

Engaging the transmission into gear, the input shaft from the transmission must be disengaged from the engine.

The pedal is released slowly, it provides a gradual engagement of the drive, as the facings slips of the friction slip, and this lets the torque to be applied continuously until these two units are connected very tightly.

Choosing different ratio, changing gears when the vehicle is moving, for this to happen, the engine torque from the transmission must be interrupted.

The disengaged of the transmission that causes the vehicle to stop and let the engine run at idling speed.

The co-efficient of friction between the friction facings and their mating surfaces, the total spring force and the amount of facings in contact can decide the torque that is transferred by the clutch. If you want to increase the torque capacity, the diameter of the clutch needs to be increased and

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this will cause the spring force to increase. Multi plate clutch can be made by having two or more clutch plates as well as increasing the number of facings and torque capacity. They are useful where by reducing the diameter is beneficial or where by increasing the spring strength is undesirable. (CDX online eTextbook).

## **9. Advantages of manual transmission system**

The manual transmission vehicles are usually cheaper and good in maintenance compare to the automatic ones, this is because changing of the fluid can be very less, also when it breaks down it is more than likely that the clutch needs to be replaced and this can save you a lot from buying a new or second hand transmission.

It gives better control because of the faster shift response, this is mainly due to the bad weather. They can as well be good in braking because the driver is not fighting the effort of the automatic transmission to move forward. It can be good in terms of fuel economy because you can shift the gear into neutral and avoiding driving in lower gears.

A skilled driver at shifting gears will have a better traction in snowy, muddy or slippery conditions and might as well be easier to get of the dangerous situation than automatic one. Manual transmission is also lighter in weight.

And there is a fun point of view in driving manual because it keeps you active and keeps you aware of what is going on around you (Moore, S. 2010)

## **10. Disadvantages of manual transmission system**

Driving manual car in traffic can be very pain full especially when there is a stop start driving, automatic cars are more comfortable in this case.

It is very unlikely to find a manual transmission car with a cruise control.

Most car now are built in automatic transmission so there is less availability of cars with manual transmission as well as the difficulties in learning how to drive manual transmission cars.

## **11. Report Summary**

This has been a successful report and I have researched a lot of information about this topic. Indeed I have acquired a lot transmission system. Here are some few pointed aligned below:

History of the transmission

What is automatic transmission system

Major components of the automatic transmission and how they work

Advantages and disadvantages of automatic transmission system

What is manual transmission system

Clutch assembly and clutch components and how they work

Advantages and disadvantages of manual transmission system

## **12. Conclusions**

According to my understanding in the report, it shows the main difference between automatic transmission and manual transmission is that automatic

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transmission uses torque converter to create power while manual transmission uses clutch to engage and disengage the gears. Also automatic cars are in very high demanding since most of the components are controlled by computers now in the car. It also shows that once the automatic transmission breaks it can be very hard and complicated to fix it and this may end up in replacing the whole transmission. In terms of manual gear box, the report shows they are very hard to break or die as well as less maintenance too, this is one of the best things in manual transmission because it can last for long time without anything happen.

From my point of view I would always recommend to go for manual car if you enjoy the gear changing ration as I do.