POWER TRANSMISSION IN AUTOMOBILES

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INTRODUCTION

A machine consists of a power source and a power transmission system, which provides controlled application of the power. Merriam-Webster defines *transmission* as an assembly of parts including the speed-changing gears and the propeller shaft by which the power is transmitted from an engine to a live axle.Often **transmission** refers simply to the **gearbox** that usesgears and gear trains to provide speed and torque conversions from a rotating power source to another device.

In British English, the term *transmission* refers to the whole drivetrain, including clutch, gearbox, prop shaft (for rear-wheel drive), differential, and final drive shafts. In American English, however, the term refers more specifically to the gearboxalone, and the usage details are different.

The most common use is in motor vehicles, where the transmission adapts the output of the internal combustion engine to the drive wheels. Such engines need to operate at a relatively high rotational speed, which is inappropriate for starting, stopping, and slower travel. The transmission reduces the higher engine speed to the slower wheel speed, increasing torquein the process. Transmissions are also

used on pedal bicycles, fixed machines, and where different rotational speeds and torques are adapted.

Often, a transmission has multiple gear ratios (or simply "gears"), with the ability to switch between them as speed varies. This switching may be done manually (by the operator), or

automatically. Directional (forward and reverse) control may also be provided. Single-ratio transmissions also exist, which simply change the speed and torque (and sometimes direction) of motor output.

In motor vehicles, the transmission generally is connected to the engine crankshaft via a flywheel and/or clutch and/or fluid coupling, partly because internal combustion engines cannot run below a particular speed. The output of the transmission is transmitted via driveshaft to one or more differentials, which in turn, drive the wheels. While a differential may also provide gear reduction, its primary purpose is to permit the wheels at either end of an axle to rotate at different speeds (essential to avoid wheel slippage on turns) as it changes the direction of rotation.

Conventional gear/belt transmissions are not the only mechanism for speed/torque adaptation. Alternative mechanisms include torque converters and power transformation (for example, diesel-electric transmission and hydraulic drive system). Hybrid configurations also exist.

AUTOMOTIVE BASICS

The automobile kind of reminds me of the human body in that there are a TON of working parts. A lot of them are either physically connected or connected in the sense that their motion has to be synchronized. In today's post, I'll touch on engine function, the combustion chambers, the engine block and the crankshaft.

The main function of the engine is to create angular momentum, which is a fancy word for spinning motion. The engine creates that spinning motion by sucking in air, squishing down fuel, banging an explosion and blowing out exhaust. So the engine sucks, squishes, bangs, and blows – and yes, I am talking about a car.

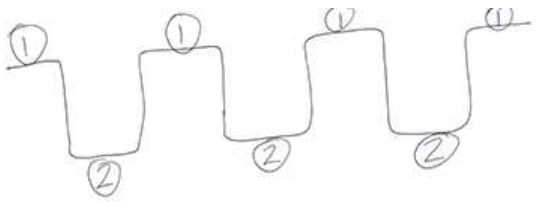
The biggest piece to the engine puzzle is the block. It's literally just that – a big block of metal. It has a lot of holes and pathways, but no actual *moving* parts – it's like a maze. There are 3 main types of holes/pathways in the engine block:

1. Combustion Chambers: these are the big holes, more on these in a minute;
2. Coolant/Antifreeze pathways: these are the medium tubes/pathways;
3. Oil pathways: these are the little pathways.

The combustion chambers play a really big role in getting the vehicle moving. This is where the magic happens. When you turn the key to your ignition, it creates a spark. When this spark touches fuel, it creates an explosion – or bang – inside each individual chamber. The only way this

can happen is if each chamber is sealed. The chambers are all sealed by what's called a head gasket(s), (more on this in later posts). Inside the combustion chambers are pistons – these pistons are *exactly* the right size and fit perfectly within each chamber. When the explosion goes off, it pushes the piston down.

Now, the ends of the pistons are connected to what's called the crankshaft. This rod, or shaft, is one of two or three rods/shafts within the engine, (more on these in later posts). The crankshaft reminds me of a jack-o-lantern's teeth because it squiggles back and forth. The pistons attach to the high and low parts of the squiggles – this is why the timing of an engine is so important. So, every other piston gets pushed down at the same time and gets sucked back up at the same time. Think of it like this, the high parts of the crankshaft are on Team 1, and the low parts are on Team 2. When Team 1 gets pushed down, Team 2 swings up and vice versa. Similar to bicycle pedals. This action makes the Crankshaft turn. Voila! The spinning motion begins!



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NON-SYNCHRONOUS TRANSMISSIONS

A non-synchronous transmission is typically found in commercial, agricultural and heavy equipment. Unlike the transmission in a family sedan, a non-synchronous transmission is much more difficult to shift. The gears in a non-synchronous transmission need to be brought up to speed in order to mesh with each other while shifting. Double clutching and a good ear for the proper engine speed aid experienced drivers in shifting a non-synchronous transmission. Once experienced, many drivers are able to shift a non-synchronous transmission without using a clutch at all.
In a typical passenger vehicle, the transmission is fully synchronized. This is also known as a constant mesh transmission, meaning that the gears are always meshed and in motion with each other. This type of transmission uses a cone and collar system to bring a gear up to the same speed as the previous gear so it can slide into gear and lock without emitting a grinding noise. The gears in this type of transmission are meshed onto the output shaft, and the gears are changed by sliding back and forth between selected gears within the transmission.

The purpose for the non-synchronous transmission is that it is a much stronger transmission than the constant mesh version. The non-synchronous transmission is able to pull much heavier loads without damage to the gears. The extremely close ratio of the gearing also allows a machine to operate at very slow wheel speed while maintaining power and high engine speeds.

SYNCHRONOUS TRANSMISSIONS

Synchronous transmission is a process where data is transferred in regular intervals that are timed by a clocking signal; allowing for a constant and reliable transmission for time-sensitive data, such as real-time video or voice. Sender and receiver are synchronized with respect to the sending and receiving of information. Each character need not have a start-bit and a stop-bit as the sender and the receiver are both synchronized .Requires more hardware and software resources .High speed communication is the norm.

AUTOMATIC TRANSMISSION

An **automatic transmission** (also called **automatic gearbox**, **self-shifting gearbox** or **A/T**) is a type of motor vehicle transmissionthat can automatically change gear ratios as the vehicle moves, freeing the driver from having to shift gears manually. Like other transmission systems on vehicles, it allows an internal

combustion engine, best suited to run at a relatively high rotational speed, to provide a range of speed and torque outputs necessary for vehicular travel.

The most popular form found in automobiles is the hydraulic automatic transmission. Similar but larger devices are also used for heavy-duty commercial and industrial vehicles and equipment. This system uses a fluid coupling in place of a friction clutch, and accomplishes gear changes by locking and unlocking a system of planetary gears. These systems have a defined set of gear ranges, often with a parking pawl that locks the output shaft of the transmission to keep the vehicle from rolling either forward or backward. Some machines with limited speed ranges or fixed engine speeds, such as some forklifts and lawn mowers, only use atorque converter to provide a variable gearing of the engine to the wheels.

MANNUAL TRANSMISSION

The function of any transmission is transferring engine power to the driveshaft and rear wheels (or axle halfshafts and front wheels in a front-wheel-drive vehicle). Gears inside the transmission change the vehicle's drive-wheel speed and torque in relation to engine speed and torque. Lower (numerically higher) gear ratios serve as torque multipliers and help the engine to develop enough power to accelerate from a standstill.

Initially, power and torque from the engine comes into the front of the transmission and rotates the main drive gear (or input shaft), which meshes with the cluster or counter shaft gear -- a series of gears forged into one piece that resembles a cluster of gears. The cluster-gear assembly rotates any time the clutch is engaged to a running engine, whether or not the transmission is in gear or in neutral.

There are two basic types of manual transmissions. The sliding-gear type and the constant-mesh design. With the basic -- and now obsolete -- sliding-gear type, nothing is turning inside the transmission case except the main drive gear and cluster gear when the trans is in neutral. In order to mesh the gears and apply engine power to move the vehicle, the driver presses the clutch pedal and moves the shifter handle, which in turn moves the shift linkage and forks to slide a gear along the mainshaft, which is mounted directly above the cluster. Once the gears are meshed, the clutch pedal is released and the engine's power is sent to the drive wheels. There can be several gears on the mainshaft 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 speeds.

All modern transmissions are of the constant-mesh type, which still uses a similar gear arrangement as the sliding-gear type. However, all the mainshaft gears are in constant mesh with the cluster gears. This is possible because the gears on the mainshaft are not splined to the shaft, but are free to rotate on it. With a constant-mesh gearbox, the main drive gear, cluster gear and all the mainshaft gears are always turning, even when the transmission is in neutral.

Alongside each gear on the mainshaft is a dog clutch, with a hub that's positively splined to the shaft and an outer ring that can slide over against each gear. Both the mainshaft gear and the ring of the dog clutch have a row of teeth. Moving the shift linkage moves the dog clutch against the adjacent mainshaft gear, causing the teeth to interlock and solidly lock the gear to the mainshaft.

To prevent gears from grinding or clashing during engagement, a constant-mesh, fully "synchronized" manual transmission is equipped with synchronizers. A synchronizer typically consists of an inner-splined hub, an outer sleeve, shifter plates, lock rings (or springs) and blocking rings. The hub is splined onto the mainshaft between a pair of main drive gears. Held in place by the lock rings, the shifter plates position the sleeve over the hub while also holding the floating blocking rings in proper alignment.

A synchro's inner hub and sleeve are made of steel, but the blocking ring -- the part of the synchro that rubs on the gear to change its speed -- is usually made of a softer material, such as brass. The blocking ring has teeth that match the teeth on the dog clutch. Most synchros perform double duty -- they push the synchro in one direction and lock one gear to the mainshaft. Push the synchro the other way and it disengages from the first gear, passes through a neutral position, and engages a gear on the other side.

That's the basics on the inner workings of a manual transmission. As for advances, they have been extensive over the years, mainly in the area of additional gears. Back in the '60s, four-speeds were common in American and European performance cars. Most of these transmissions had 1:1 final-drive ratios with no overdrives. Today, overdriven five-speeds are standard on practically all passenger cars available with a manual gearbox.

Overdrive is an arrangement of gearing that provides more revolutions of the driven shaft (the driveshaft going to the wheels) than the driving shaft (crankshaft of the engine). For example, a transmission with a fourth-gear ratio of 1:1 and a fifth-gear ratio of 0.70:1 will reduce engine rpm by 30 percent, while the vehicle maintains the same road speed. Thus, fuel efficiency will improve and engine wear will be notably reduced. Today, six-speed transmissions are becoming more and more common. One of the first cars sold in America with a six-speed was the '89 Corvette. Designed by Chevrolet and Zahnradfabrik Friedrichshafen (ZF) and built by ZF in Germany, this tough-as-nails six-speed was available in the Corvette up to the conclusion of the '96 model year. Today, the Corvette uses a Tremec T56 six-speed mounted at the back of the car.

Many cars are available today with six-speeds, including the Mazda Miata, Porsche Boxster S and 911, Dodge Viper, Mercedes-Benz SLK350, Honda S2000, BMW 3-Series and many others. Some of these gearboxes provide radical 50-percent (0.50:1) sixth-gear overdrives such as in the Viper and Corvette, while others provide tightly spaced gear ratios like in the S2000 and Miata for spirited backroad performance driving. While the bigger cars mentioned above such as the Viper and Vette often have two overdrive ratios (fifth and sixth) the smaller cars like the Celica and S2000 usually have one overdriven gear ratio (sixth) and fifth is 1:1.

Clearly a slick-shifting manual transmission is one of the main components in a fun-to-drive car, along with a powerful engine, confidence-inspiring suspension and competent brakes. For more information on a manual transmission's primary partner component, check out our basic primer on clutches and clutch operation.

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