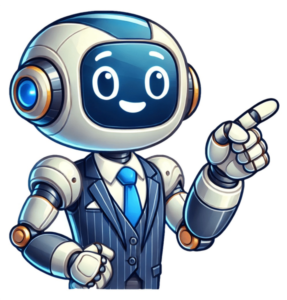

The way that gears interact with each other is important to know for anyone planning to make the most of them. Most modern cars have gear ratios that were calculated with computers, but bikes and mechanical home projects do not. If you're mystified by gear ratios, it will help to know what a gear ratio is, and how it affects other parts of your mechanical device. Where there are a number of gears meshing together, the number of teeth on them will form an important ratio: the gear ratio. When several gears are meshing together, they form what's called a gear chain. The ratio is only calculated from the first gear, the driving gear which is attached to the power source, and the last gear in the chain. If you count up the number of teeth on gear one, and on gear X (the last one) and set them in a ratio (1:X), this is the gear ratio. If the number can be reduced, you should reduce it, for example a ratio of 100 teeth:40 teeth reduces to 5:2. The gear ratio is necessary for calculating the speed a given gear chain will produce. When you have that information, you have half of the information needed to calculate the speed. The equation is Speed(Gear 1) * Teeth (Gear 1) = Speed (Gear X) * Teeth (Gear X). So, if you have the speed the motor is putting into the gears, you can very easily calculate the speed of gear X. On a bike, you have a slightly different system: instead of a pair of gears meshing directly, they're attached by a pulley chain, but the gear ratio still applies. On a mountain bike, for example, you have a set of concentric gears attached to the pedals, and more gears attached to the drive wheel. The ratio of teeth on the wheel gear to the teeth on the pedal gear will still form a ratioand if you pedal at a set speed on the bike, changing that gear ratio will change how fast you go. In a gear chain, when there are a number of gears in the middle, something fairly interesting happens to the middle gears. You may have noticed that in the previous calculations, the only gears that are important are the first and last. This is because gears in between don't impact the speedthey'll go as fast or slow as they need to. What they will change, however, is the direction: if there's an odd number of gears, the first and last will turn in the same direction. Turner, Grahame. "Simple Gear Ratio Explained" sciencing.com, . 24 April 2017. APA Turner, Grahame. (2017, April 24). Simple Gear Ratio Explained. sciencing.com. Retrieved from Chicago Turner, Grahame. Simple Gear Ratio Explained last modified March 24, 2022. If you want to create a high gear ratio, nothing beats the worm gear. On a worm gear, a threaded shaft engages the teeth on a gear. Each time the shaft spins one revolution, the gear moves one tooth forward. If the gear has 40 teeth, you have a 40:1 gear ratio in a very small package. Worm gears allow windshield wipers to function. A mechanical odometer is another place that uses a lot of worm gears. Planetary Gears There are many other ways to use gears. One specialized gear train is called a planetary gear train. Planetary gears solve the following problem. Let's say you want a gear ratio of 6:1 with the input turning in the same direction as the output. One way to create that ratio is with the following three-gear train. In this train, the blue gear has six times the circumference of the yellow gear (giving a 6:1 ratio). The size of the red gear is not important because it is just there to reverse the direction of rotation so that the blue and yellow gears turn the same way. However, imagine that you want the axis of the output gear to be the same as that of the input gear. A common place where this same-axis capability is needed is in an electric screwdriver. In that case, you can use a planetary gear system, as shown here. In this gear system, the yellow gear (the sun) engages all three red gears (the planets) simultaneously. All three are attached to a plate (the planet carrier), and they engage the inside of the blue gear (the ring) instead of the outside. Because there are three red gears instead of one, this gear train is extremely rugged. The output shaft is attached to the blue ring gear, and the planet carrier is held stationary this gives the same 6:1 gear ratio. You can see a picture of a two-stage planetary gear system on the electric screwdriver page, and a three-stage planetary gear system of the sprinkler page. You also find planetary gear systems inside automatic transmissions. Another interesting thing about planetary gearsets is that they can produce different gear ratios depending on which gear you use as the input, which gear you use as the output, and which one you hold still. For instance, if the input is the sun gear, and we hold the ring gear stationary and attach the output shaft to the planet carrier, we get a different gear ratio. In this case, the planet carrier and planets orbit the sun gear, so instead of the sun gear having to spin six times for the planet carrier to make it around once, it has to spin seven times. This is because the planet carrier circled the sun gear once in the same direction as it was spinning, subtracting one revolution from the sun gear. So in this case, we get a 7:1 reduction. You could rearrange things again, and this time hold the sun gear stationary, take the output from the planet carrier and hook the input up to the ring gear. This would give you a 1.17:1 gear reduction. An automatic transmission uses planetary gearsets to create the different gear ratios, using clutches and brake bands to hold different parts of the gearset stationary and change the inputs and outputs. 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Sergey Kohl / Shutterstock You see gears in just about everything that has spinning parts. For example, car engines and transmissions contain lots of gears. If you ever open up a VCR and look inside, you will see it is full of gears. Wind-up, grandfather and pendulum clocks contain plenty of gears, especially if they have bells or chimes. You probably have a power meter on the side of your house, and if it has a see-through cover, you can see that it contains 10 or 15 gears. Gears are everywhere where there are engines and motors producing rotational motion. Read on to learn about gears, gear ratios and gear trains so that you can understand what all the different gears you see are doing. Gears are generally used for one of four different reasons: To reverse the direction of rotationTo increase or decrease the speed of rotationTo move rotational motion to a different axisTo keep the rotation of two axes synchronized Understanding the concept of the gear ratio is easy if you understand the concept of the circumference of a circle. Keep in mind that the circumference of a circle is equal to the diameter of the circle multiplied by pi (pi is equal to 3.14159...). Therefore, if you have a circle or a gear with a diameter of 1 inch, the circumference of that circle will be 3.14159 inches. Let's say that you had two circles: one with a diameter of 1.27 inches and another with a diameter of 1.27 inches / 2 = 0.635 inches. The larger of the two circles has a circumference of 4 inches. If you rolled both circles, you would find that the smaller one has to complete two full rotations to cover the same 4-inch line as the larger one. This explains why two gears one half as big as the other have a gear ratio of 2:1. The smaller gear has to spin twice to cover the same distance covered when the larger gear spins once. Most gears that you see in real life have teeth. The teeth have three advantages: They prevent slippage between the gears. Therefore, axles connected by gears are always synchronized exactly with one another.They make it possible to determine exact gear ratios; you just count the number of teeth in the two gears and divide. So if one gear has 60 teeth and another has 20, the gear ratio when these two gears are connected together is 3:1.They make it so that slight imperfections in the actual diameter and circumference of two gears don't matter. The number of teeth control the gear ratio, even if the diameters are a bit off. To create large gear ratios, gears are often connected together in gear trains, as shown here: The right-hand (fuchsia) gear in the train is actually made in two parts, as shown. A small gear and a larger gear are connected together, one on top of the other. Gear trains often consist of multiple gears in the train, as shown in the following two figures: In the case above, the fuchsia gear turns at a rate twice that of the purple gear. The green gear turns at twice the rate as the fuchsia gear. The pink gear turns at twice the rate as the green. The gear train shown below has a higher gear ratio: In this train, the smaller gears are one-fifth the size of the larger gears. That means that if you connect the purple gear to a motor spinning at 100 rpm (revolutions per minute), the green gear will turn at a rate of 500 rpm and the pink gear will turn at a rate of 2,500 rpm. In the same way, you could attach a 2,500 rpm motor to the pink gear to get 100 rpm on the purple gear. If you can see inside your power meter and it is of the older style with five mechanical dials, you will see that the five dials are connected to one another through a gear train like this, with the gears having a ratio of 10:1. Because the dials are directly connected to one another, they spin in opposite directions (you will see that the numbers are reversed on dials next to one another). For more information on gear ratios, visit our gear ratio chart. There are many other ways to use gears. For example, you can use conical gears to bend the axis of rotation in a gear train by 90 degrees. The most common place to find conical gears like this is in the differential of a rear-wheel-drive car. A differential bends the rotation of the engine 90 degrees to drive the rear wheels: Another specialized gear train is called a planetary gear train. Planetary gears solve the following problem. Let's say you want a gear ratio of 6:1. One way to create that ratio is with the following three-gear train: In this train, the red gear has three times the diameter of the yellow gear, and the blue gear has two times the diameter of the red gear (giving a 6:1 ratio). However, imagine that you want the axis of the output gear to be the same as that of the input gear. A common place to need this same-axis capability is in an electric screwdriver. In that case, you can use a planetary gear system, as shown here: In this gear system, the yellow gear engages all three red gears simultaneously. They are all three attached to a plate, and they engage the inside of the blue gear instead of the outside. Because there are three red gears instead of one, this gear train is extremely rugged. The ouput shaft is taken from the plate, and the blue gear is held stationary. You can see a picture of an two-stage planetary gear system on the electric screwdriver page. Finally, imagine the following situation: you have two red gears that you want to keep synchronized, but they are some distance apart. You can place a big gear between them if you want them to have the same directions of rotation: Or you can use two equal-sized gears if you want them to have opposite rotational direction: However, in both of these cases the extra gears are likely to be heavy and you need to create axles for them. In these cases the common solution is to use either a chain or a toothed belt, as shown here: The advantages of chains and belts are light weight, the ability to separate the two gears by some distance, and the ability to connect many gears together on the same chain or belt. For example, in a car engine, the same toothed belt might engage the crankshaft, two camshafts and the alternator. If you had to use gears in place of the belt, it would be a lot harder! In this post, you will learn what is gear ratio in gears? and how to calculate the gear ratio. Also, you can download the PDF file at the end of this article.Thegear ratiois theratioof the number of turns the output shaft makes when the input shaft turns once. In other words,the Gear ratiois the ratio between the number of teeth on twogearsthat are meshed together, or two sprockets connected with a common roller chain, or the circumferences of twopulleysconnected with a drivebelt.Dont miss out: What are the Types of Gear Cutting Process? Their Advantages, Disadvantages [PDF]The tooth and wheel of the gear are basic workings parts of all types of gears. The different types of gear are usedto execute the transfer of energy in a different direction. For instance, when two gears of different sizes mesh and rotate, the pinion will turn faster and with less torque than the larger gear.The teeth of the gear are principally carved on wheels, cylinders, or cones. Many devices that we use in our day-to-day life there working principles as gears.Often gears that are meshed together will be of different sizes.In this case,The smaller gear is referred to as the pinion andThe larger one is simply referred to as the gear.Gear is differentfrom a pulley. Gear is a round wheel that has teeth that mesh with other gear teeth, allowing the force to be fully transferred without slippage.To overcome the problem of slippage as in belt drives, gear is used which produces a positive drive with uniform angularvelocity. When two or more gears mesh together the arrangement is called a gear set or a gear train.Read about:Gear Terminology [This is one of the Easiest Guide on Gears]For example, a pinion with 18 teeth is mounted on a motor shaft and is meshed with a larger gear that has 54 teeth.During operation, the pinion makes three complete revolutions for every single revolution of the larger gear.This relationship in which the gear turns at one-third of the pinion speed is a result of the number of teeth on the pinion and the larger gear. This relationship is called the gear teeth pinion teeth ratio or the gear ratio.This ratio can be expressed as the number of gear teeth divided by the number of pinion teeth. So in this example, since there are 54 teeth on the larger gear and 18 teeth on the pinion. Theres a ratio of 54 to 18 or 3 to 1 this means that pinion is turning at three times the speed of the gear.Now often more than one gear set is used in a gearbox multiple gear sets may use in place of one large set because they take up less space.However, the gear ratio can still be used to determine the output of a gearbox.Lets see how this illustration consists of two gear sets. This gear set has a pinion with 10 teeth and a gear with 30 teeth. The second gear set consists of an opinion with 10 teeth and a gear with 40 teeth.In our example, the input shaft is turned by an external device such as a motor. And the output shaft is connected to a machine to drive, such as a pump or a fan its often called the output shaft.The input shaft and output shaft are connected by the intermediate shaft.Now by using the gear ratio formula we looked at earlier, we can determine the ratio across the gears. The first gear set is 30 over 10 or 3 to 1. And that the ratio across the second gear set is 40 over 10 or 4 to 1. This information can be used to determine the ratio across the entire series of gears.Thats done by multiplying the ratio of the first gear set by the ratio of the second gear set.So 3 / 1 times 4 / 1 results in a ratio of 12 / 1 this means that for every 12 revolutions of the input shaft the output shaft will complete one revolution. Or in other words, the motor shaft is turning 12 times faster than the pump shaft.Well, so far weve looked at how a speed can be changed across the gear set and weve seen how this change can be described by you.Gear ratios can be used to determine the speed of rotation of a gear set if the input or output speed of the gear set is known.Download PDF of this article:If you find this article helpful share it with your friends. Have any doubts or questions about Gear Ratio leave a comment Ill respond.Subscribe to our newsletter to get notification of new articles:Shaper machine, Drilling machine, Planner machine, and more. Published: Mar 08, 2020 10:52 AM ESTGear ratios are a core science behind almost every machine in the modern era. They can maximize power and efficiency and are based on simple mathematics. So, how do they work?If you work with gear ratios every single day, this post probably isnt for you. But, if you want to improve your understanding of this essential element of machine design, keep reading. Gear ratios are simple as long as you understand some of the math behindcircles. Ill spare you the grade school math, but it is important to know that the circumference of a circle is related to a circles diameter. This math is important in gear ratio design. To begin to understand gear ratios, its easiest if we start by removing the teeth from the gears. Imagine two circles rolling against one another, and assuming no slippage, just like college Physics 1. Give circle one a diameter of 2.54 inches. Multiplying this by pi leaves us with a circumference of 8 inchesor, in other words, one full rotation of the circle one will result in 8 inches of displacement. Give circle two a diameter of .3175 inches, giving us a circumference of 1 inch. If these two circles roll together, they will have a gear ratio of 8:1, since circle one has a circumference8 times as big as circle two. A gear ratio of 8:1 means that circle two rotates 8 times for every time circle one rotates once. Dont fall asleep on me yet; we are going to get more and more complex.Gears arent circles because, as you know, they have teeth. Gears have to have teeth because, in the real world, there isnt infinite friction between two rolling circles. Teeth also make exact gear ratios very easy to achieve. Rather than having to deal with the diameters of gears, you can use the number of teeth on a gear to achieve highly precise ratios. Gear ratios are never just arbitrary values, they are highly dependent on the needed torque and power output, as well as gear and material strength. For example, if you need a gear ratio of 3.57:1, it would be possible to design two compatible gears, one with 75 teeth and another with 21.RELATED: THIS GEARED TURBOFAN IS 15 PERCENT MORE EFFICIENT THAN OTHER AIRPLANE ENGINESAnother big aspect that plays into the use of teeth in gears is manufacturing tolerances. Most gears can be built with fairly wide tolerances, and we know that the tighter a tolerance gets, the more expensive it is to manufacture. Teeth allow for the manufacturing of gears with set diameters to be somewhat variant, which means manufacturing is cheaper. Essentially, teeth become a buffer that allows for imperfections in gear manufacturing. While the basic gear ratio is fairly simple to understand, it can also get much more complicated. Large spans of gears, called gear trains, are often necessary in machine design. These consist of many gears, which are often stacked or laid in succession. Gear trains are necessary to achieve more robust gear ratios, as well as affecting the direction of rotation. Since two connected gears will rotate in opposite directions, gear trains are often needed to translate power through specific ratios without affecting rotation. For example, using a three-geared gear train,with a gear ratio of 1:5, would yield a 2500% increase in rotation speed, while keeping the output in the same direction as the input. To give a more concrete example, a motor that applied 100 RPM to the beginning end of this gear train would output 2500 RPM on the other end in the same direction. You could also reverse where the power is applied and step down a 2500 RPM motor to an output of 100 RPM. These changes allow you to adjust both torque and speed.RELATED: FUTURISTIC RUSSIAN INFANTRY GEAR RECIEVES NUCLEAR RESISTANT UPGRADEMore complex combinations of gears and gear ratios yield some interesting machine designs. Theoretically, gear ratios are simple, but as an engineer, you may find yourself involved in complex gearing designs that seem just a little overwhelming. As with other engineering skills, it takes time to fully develop skills in gear ratio design.Transmissions practical applications of gear ratiosTransmissions are some of the best examples of the practical applications of gear ratios. Anyone who has ridden in a car or other motorized vehicle has benefited from transmissions in some form. And every transmission is essentially just a bunch of gears and gear ratios packed closely together. Take a look at the incredibly helpful video from Learn Engineering below to learn more about how manual transmissions work. Its important to note that while manual transmissions are falling out of favor with automakers, as they are not easy to incorporate in hybrid or electric vehicles, they function almost identically to how automatic transmissions work, as far as gearing goes. The main difference is in how the gears are shifted.RELATED: FIVE TRENDS SHAPING THE AUTOMOTIVE INDUSTRY IN 2020Manual transmissions will involve action by the user (moving the gear shift and clutch) to shift, whereas automatic transmissions will use input from the cars onboard computer or, in very early models, mechanical input from either the cars speed or the cars engine.Trevor English Trevor is a civil engineer (B.S.) by trade and an accomplished writer with a passion for inspiring everyone with new and exciting technologies. He is also a published children's book author and the producer for the YouTube channel Concerning Reality.Stay up-to-date on engineering, tech, space, and science news with The Blueprint.By clicking sign up, you confirm that you accept this site's Terms of Use and Privacy PolicyNewsscience

What is step ratio in gearbox. How are gear ratios calculated. Gearbox gear ratios. Gearbox ratio i. Transmission gear ratios explained. Gearbox gear ratios explained.