# How I Designed a 3D Printed Windup Car Using Autodesk Fusion 360.

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## Short description:

Designing a 3D Printed Windup Car using Autodesk Fusion 360.

## Description:

https://www.youtube.com/watch?v=EAgUQOUJbvU I've designed, 3D printed, assembled, tested and published quite a few PLA spring motor floating pinion cars and demonstrators over the last few years, so why would I design, print, assemble, test and publish yet another one? Well, "How I Designed a 3D Printed Windup Car Using Autodesk Fusion 360" includes a four part video series detailing how I designed this 3D printed windup car (with floating pinion drive) using Autodesk Fusion 360. And I've also included the Autodesk Fusion 360 cad file "Windup Floating Pinion Car.f3d" containing the completed design (familiarity with the Autodesk Fusion 360 environment is highly recommended, and if a discrepancy is found between the videos and the cad file, use the cad file). So if you're interested in my design process for a PLA spring motor powered windup car with floating pinion drive, and / or wish to modify the design to create your own custom version, then this Instructable may indeed be of interest to you. And if you're simply interested in 3D printing and assembling the car, I've included all STL files required to print the car, along with preparation and assembly instructions. And finally, what's a floating pinion? In this design a floating pinion is a pinion gear that traverses a guide slot, engaging the PLA spring motor with the drive axle when spring energy is present, and disengaging the PLA spring motor from the drive axle when spring energy is depleted. By disengaging the PLA spring motor from the drive axle, the car is allowed to coast, as opposed to abruptly stopping, when spring energy is depleted providing a significant increase in travel distance. And as usual, I probably forgot a file or two or who knows what else, so if you have any questions, please do not hesitate to ask as I do make plenty of mistakes. Designed using Autodesk Fusion 360, sliced using Cura 4.0, and printed in PLA and Tough PLA on an Ultimaker 2+ Extended and an Ultimaker 3 Extended. <b>Designing the Spring Motor.</b> https://www.youtube.com/watch?v=io9Wry74p8g The spring motor consists of the "Knob.stl", "Spring.stl", "Pawl.stl" and "Gear, Pawl (24, 2.2).stl". The knob is used to wind the spring, and the pawl and pawl gear provide the ratchet mechanism for winding. As with all components of this model, I design using what I call "sketch in place" which keeps the sketch in position with the extruded component for easier editing. The pawl gear, as with all gears used in this model, was designed using a module of 2.2. There are only two gear sizes used in this model; twenty four and eight tooth. For a twenty four tooth gear, the pitch radius is ((24 * 2.2) / 2) or 26.4mm. For an eight tooth gear, the pitch radius is ((8 * 2.2) / 2) or 8.8mm. These dimensions will be used in the next step. <b>Designing the Gear Train.</b> https://www.youtube.com/watch?v=E-2HIeeEkP4 Math, math and more math... The gear train consists of the three gears "Gear, Compound ((24, 2.2), (8, 2.2)).stl", "Gear, Floating Pinion (8, 2.2).stl" and "Gear, Axle (8, 2.2).stl", that transfer the PLA spring motor energy to the drive axle. As mentioned in the previous step, I used a module value of 2.2 for both the twenty four and eight tooth gears (in practice, when designing a gear train, it is best to use the same module for all gears in the gear train). To determine the spacing between a twenty four and eight tooth gear, the equation I use is: ((24 * 2.2) / 2) + ((8 * 2.2) / 2) + .4mm = 35.6mm. This simple equation adds the pitch radius of the twenty four tooth gear to the pitch radius of the eight tooth gear, then adds .4mm for slight additional clearance between the gears to account for 3D printing variances (make sure your 3D printer is not over extruding, and don't forget to carefully remove the build plate side "ooze" from the gears using jewelers files or equivalent). Similarly, the spacing between two eight tooth gears with a module of 2.2 is: ((8 * 2.2) / 2) + ((8 * 2.2) / 2) + .4mm = 18mm. These two dimensions, 35.6mm and 18mm, are used in this video to space the gears in the gear train. The total gear ratio from the PLA spring motor to the drive axle is 1:9 (drive to driven), using two gear stages of 1:3 each (e.g. (24 teeth / 8 teeth) = 3, and (3 * 3) = 9). This results in for each rotation of the spring motor, the drive axle will rotate nine times (which is an increase in rotational rate from the PLA spring motor to the drive axle, at the expense of a loss in torque). Thus with a wheel diameter of 47.5mm (as measured using a digital caliper with the O-Rings I used), the distance the car will travel under spring power is approximately (assuming zero traction and friction losses): (pi * wheel diameter) * 1.25 * 9 = 1678.788574262046mm = 5.5 feet, where: 1) (pi * wheel diameter) = wheel circumference = 149.2256510455152mm, 2) 1.25 is the number of winds of the PLA spring motor knob, hence the number of times the PLA spring motor will rotate (discounting friction loss and failure to remove the build plate "ooze"), 3) 9 is the total gear ratio from the PLA spring motor to the drive axle (again, drive to driven). To test the math, I fully wound the PLA spring motor, held the car firmly on a smooth surface along side an extended tape measure, then moved the car forward by hand noting that the floating pinion gear indeed disengaged the PLA spring motor from the drive axle at exactly 5'6" (ok, math isn't that bad after all). Finally, remember after the PLA spring motor energy is depleted, the floating pinion disengages the PLA spring motor from the drive axle allowing the car to coast. During testing, my cars coasted an additional 15 feet and more after the PLA spring motor energy was depleted. <b>Designing the Chassis.</b> https://www.youtube.com/watch?v=k0e-XgTPnS8 Whew, glad that math is over... The chassis consists of the two frames, "Frame, Right.stl" and "Frame, Left.stl". To gain additional ground clearance, in this video the gear train layout is modified, then the PLA spring motor and gear train components are used to assist with laying out the right frame. With the right frame complete, the left frame is created by "projecting" the right frame profile, then modifying the various socket and crossmember profiles to allow mating of the two frame sides. <b>Designing the Axles and Wheels.</b> https://www.youtube.com/watch?v=ZS41pWYm3Rs There are two unique axles "Axle, Gear, Floating.stl" and "Axle.stl", and one unique "Wheel.stl" designed in this step. After centering the car assembly, the rear axle is designed and then copied and pasted to create the front axle. Next the floating pinion axle is designed and positioned With the axle designs completed, the wheel is designed, then copied and pasted to create the remaining wheels.