2018 FLYSET FTC Workshop - 6 Wheel Geared Drive

(9/3/2018)

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- 8th year in FIRST
- 2nd year in FTC
- Main Builder and Driver for team 12810 last season
- 8th Grade at Fowler Middle School
- Hobbies: Playing video games and tennis

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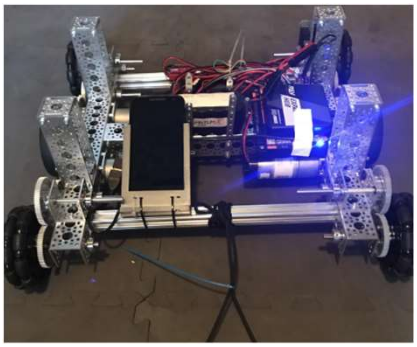
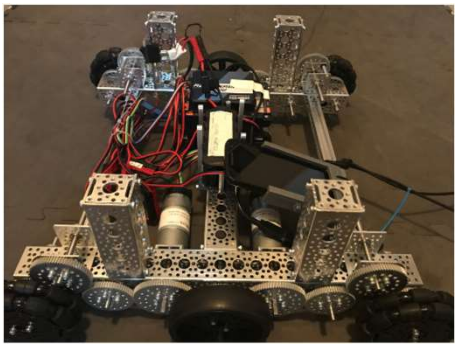
Chassis Specification

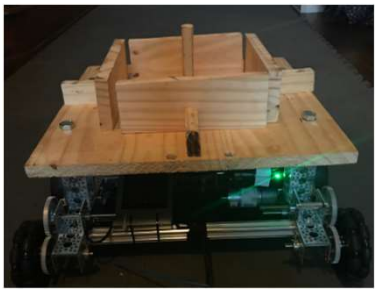
Six Wheel Geared Drive



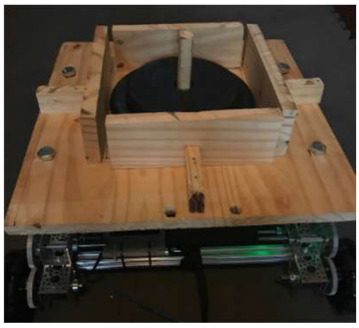


Base Weight: 13lbs

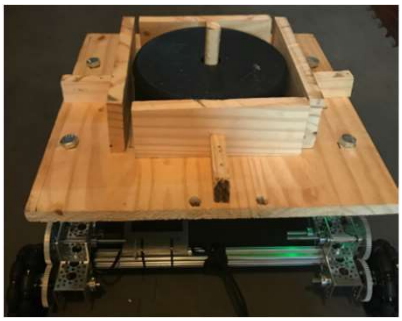
Six Wheel Geared Drive



18 lbs



33 lbs



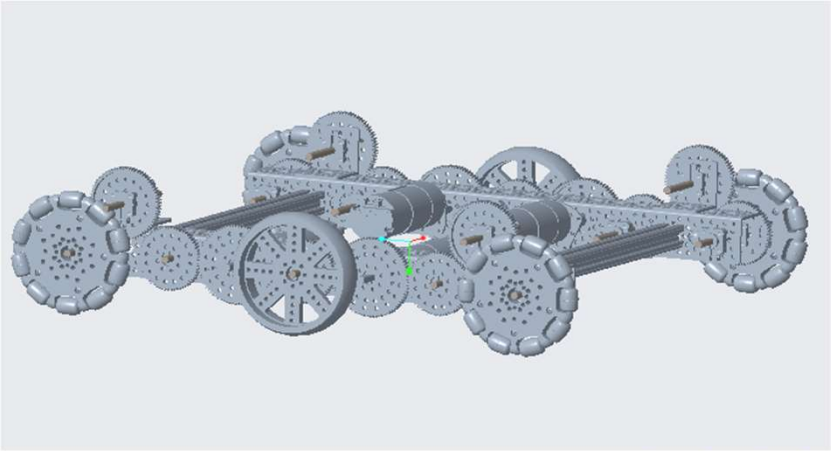
48 lbs

Six Wheel Geared Drive

- Actobotics based chassis
- Four NeveRest 40 motors
- Gear ratio from motor to wheel: 80:64 = 5:4 (equivalent to NeveRest 30)
- Consists of four pairs of 4-inch omni wheels and two 4-inch threaded drive wheels
- REV expansion hub is flat mounted on the robot chassis
- Base chassis weight (including the weight support tray): 18 lbs
- A tray on top to contain the weights during the load tests

Chassis CAD Design

Six Wheel Geared Drive in Design Phase



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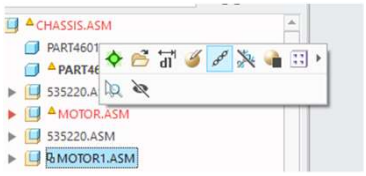
Six Wheel Geared Drive CAD Notes

- I didn't know how to edit constraints
  - Select the part and click on the icon with a ball and pen
- I got many yellow caution triangles on the shaft coupler in the navigation tree, but it never caused me any problems for simulation



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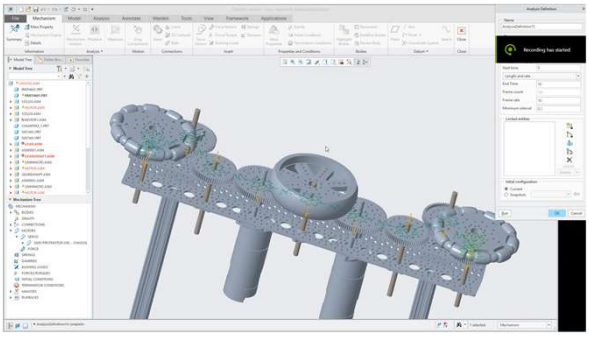
Six Wheel Geared Drive CAD Model Simulation



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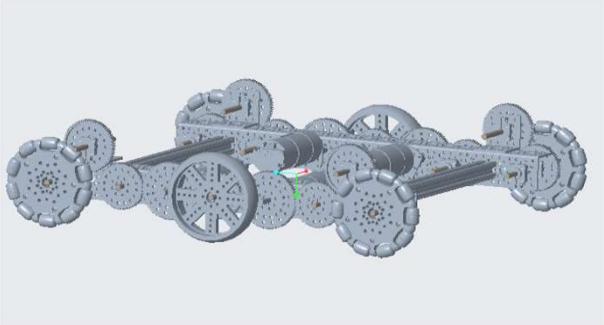
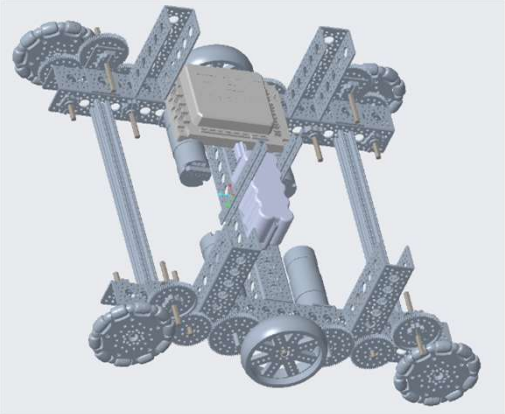
Six Wheel Geared Drive CAD Model Comparison





Chassis Test Results

6 Wheel Geared Drive Build Notes

- At first, my robot couldn't even manage to move in a straight line, tilting a whole 1.5 feet to the left
- My motors became really loose after I did my first movements, so I had to tighten them more

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Test 1: Forward Speed Test

- Observation
  - Heavy load actually helps the robot go in a straight line

	No load	15 lb load	30 lb load
Distance traveled	5.6 m	5.46 m	5.37 m

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Test 2: 3 Second Turn Test

- Observation
  - The robot went over two rotations

	No load	15 lb load	30 lb load
Degree turned	781	728	668

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Test 3: Driving up/down a ramp

- Observation
  - Easy access up and down

	No load	15 lb load	30 lb load
Up ramp	Yes	Yes	Yes
Down ramp	Yes	Yes	Yes

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Test 4: Balance Stone balancing ability

- Observation
  - Easy access up and down (facing edge)

	No load	15 lb load	30 lb load
Go on the stone?	Yes	Yes	Yes
How long on the stone? (forever is settled on the stone)	Forever	Forever	Forever

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Test 5: Pull Strength Test

- Observation
  - 10 - 20 pounds, the more load, the speed increases
  - 30 pounds, the more load, the speed decreases

	No load	15 lb load	30 lb load
10 lb pull weight	4.41 seconds	4.33 seconds	4.16 seconds
20 lb pull weight	N/A	6.44 seconds	5.31 seconds
30 lb pull weight	N/A	7.23 seconds	7.86 seconds

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Test 6: Autonomous Straight Line Drift Test (Optional)

- Observation
  - The weights barely affect the drifting of the robot

	No load	15 lb load	30 lb load
Horizontal drift	2.16 cm	1.16 cm	1.66 cm

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Test 7: Autonomous 90/180 degree turn offset (Optional)

- Observation
  - The Kp was turned for the 15 pound load

	No load	15 lb load	30 lb load
90 degree turn drift	12.1	3.3	11.83
180 degree turn drift	7.4	1.3	7.3

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6 Wheel Geared Drive Summary

- 6 wheel drive excels at turning compared to the other chassis
- Four motor drive helps the robot have access to the ramp and balancing stone
- Due to the limit of the gear sizing, I had to utilize all 14 gears (not efficient) and made the chassis the heaviest among all chassis
- Geared drive requires correct spacing or you will have to rely on custom built channels
- My center drive wheels weren't lowered, but they were accommodated by my 8-omni wheels on both ends

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DC Motor

Factors Contributing to Drifting

- Friction
- Balanced Weight
- ***Balanced Motor Speeds***
  - Brand new motors are not always identical

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DC Motor Speed Comparison

- Run both motors together with no load
  - Use autonomous program to set both motor power at 100%
  - Run for 3 seconds
- Check the values of the encoder on telemetry output
- The speed reading depends on battery voltage
- When testing more motors, the battery needs to stay at the same voltage during each test (Steady Power Source is preferred)

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Comparison Data

Currently Matched Motors (Avg Value Difference Within 100):

Motor 1	14409	14437	14442
Motor 2	14499	14502	14523
Motor 1	14437	14452	14429
Motor 3	14367	14424	14400
Motor 1	14452	14454	14439
Motor 4	14459	14445	14432
Motor 2	14476	14470	14476
Motor 3	14391	14422	14425

Biggest Gap Observed for Unmatched Motors: 1000

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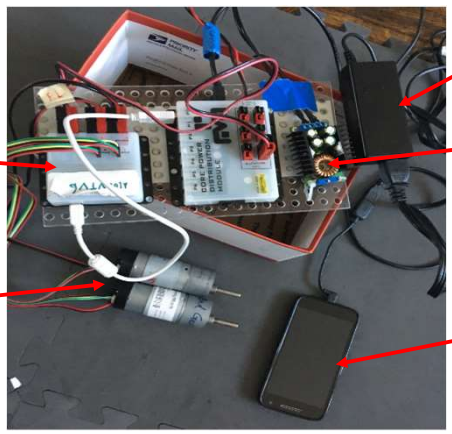
Test Setup



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DC Motor Key Metrics

- **Stall Current** - at the point when the motor has enough torque to make RPM decrease to 0
- **Stall Torque** - maximum torque the motor is able to output (measured when the motor is drawing its full **Stall Current** and when the RPM is equal to 0)
- **Free Speed** - the angular velocity the motor will spin when powered at the operating voltage with zero load on the shaft

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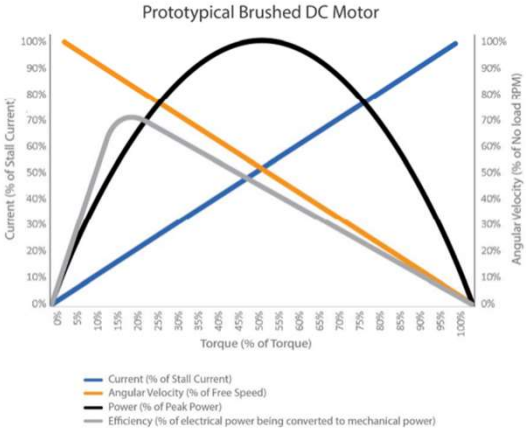
Selecting DC Motor

- Estimate the Power requirement
  - Maximum Power / Power Required
- Find the balanced range between the torque and angular velocity
- **A General Rule of Thumb:** Geared Drive is almost always more efficient than Chained Drive (chained drive is more flexible)



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Hex Motor 20 v.s. NeveRest Motor 20

Key Metrics	HD Hex 20 : 1	NeveRest 20
Stall Current	8.5 AMPs	11.5 AMPs
Stall Torque	297.4 oz * inch	197 oz * inch
Free Speed	300 RPM	315 RPM
OutPut Power	15 Watts	14 Watts

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Hex Motor 40 v.s. NeveRest Motor 40

Key Metrics	HD Hex 40 : 1	NeveRest 40
Stall Current	8.5 AMPs	11.5 AMPs
Stall Torque	594.7 oz * inch	350 oz * inch
Free Speed	150 RPM	160 RPM
OutPut Power	15 Watts	14 Watts

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TorqueNADO v.s. NeveRest Motor 60

Key Metrics	NADO	NeveRest 60
Stall Current	8.7 AMPs	11.5 AMPs
Stall Torque	700 oz * inch	593 oz * inch
Free Speed	100 RPM	105 RPM
OutPut Power	N/A	14 Watts

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