2019 FLYSET FTC Workshop

Linear Slide Design and Configuration

(8/24/2019)

Presenter

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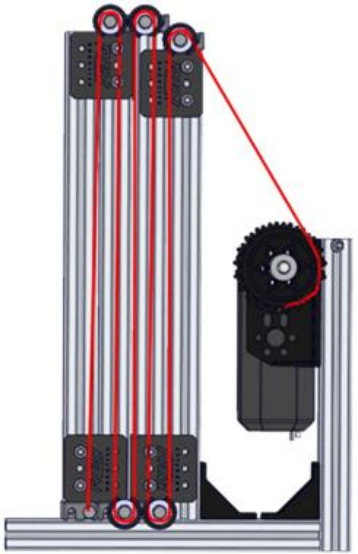
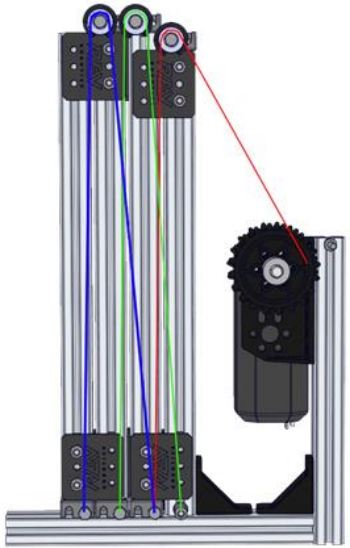
- Joined FTC this year
- Hobbies include building circuits and swimming

Project Background

Background



Continuous

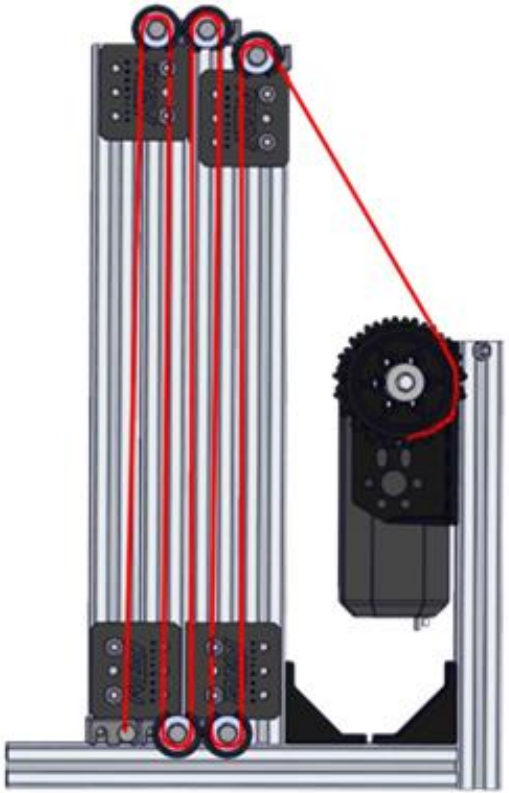


Cascade

Continuous

Pros: Less tension on string, less power required, lift more weight

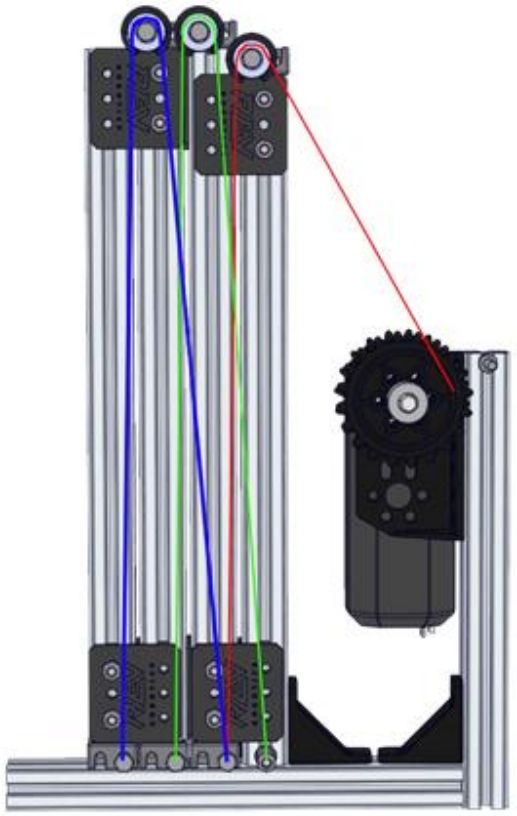
Cons: Slower



Cascade

Pros: Significantly faster

Cons: More power and torque required, able to lift less weight



Project Design

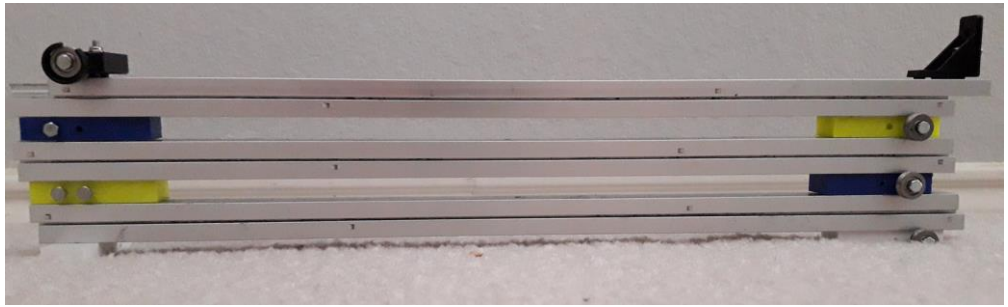
Goals

- Compare continuous and cascade linear slides
- Compare the Rev linear slide with Misumi
- Measure characteristics during testing

Top: Misumi
Cost: About $25 per segment

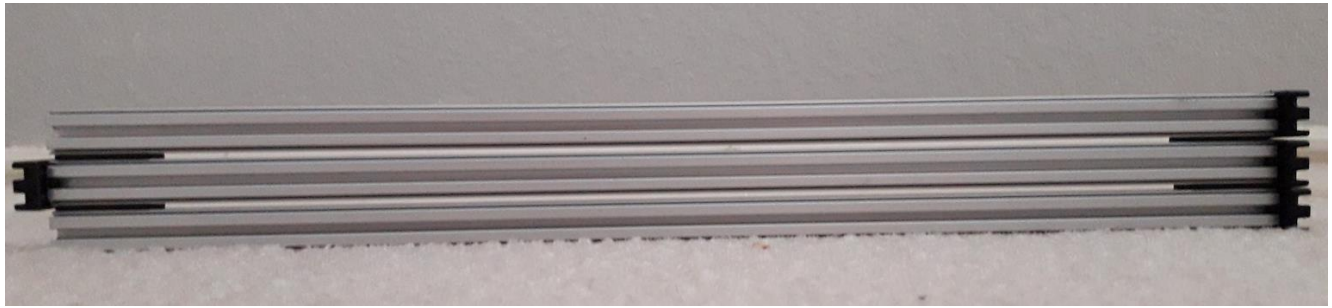
Bottom: Rev
Cost: $14 per segment

Goals



Top: Misumi

Bottom: Rev



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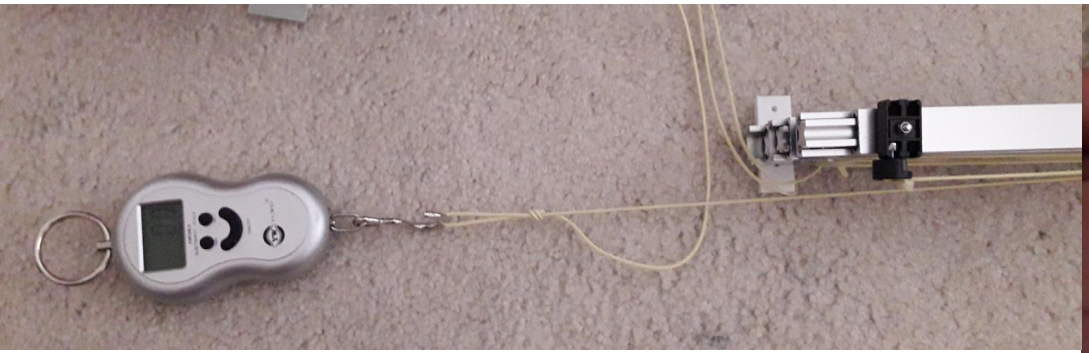
Characteristics to Measure

- Time
- Motor speed
- Power Usage (Energy = Volts x Amps x Time)
- Torque (T = Frictional Force x motor shaft radius)

  Frictional Force = Friction Coefficient x Mass of load and slides x acceleration due to gravity

Friction Coefficient Estimate

Friction Coefficient = force required for constant velocity / (mass*acceleration due to gravity)



Measuring force

Friction Coefficient Estimate

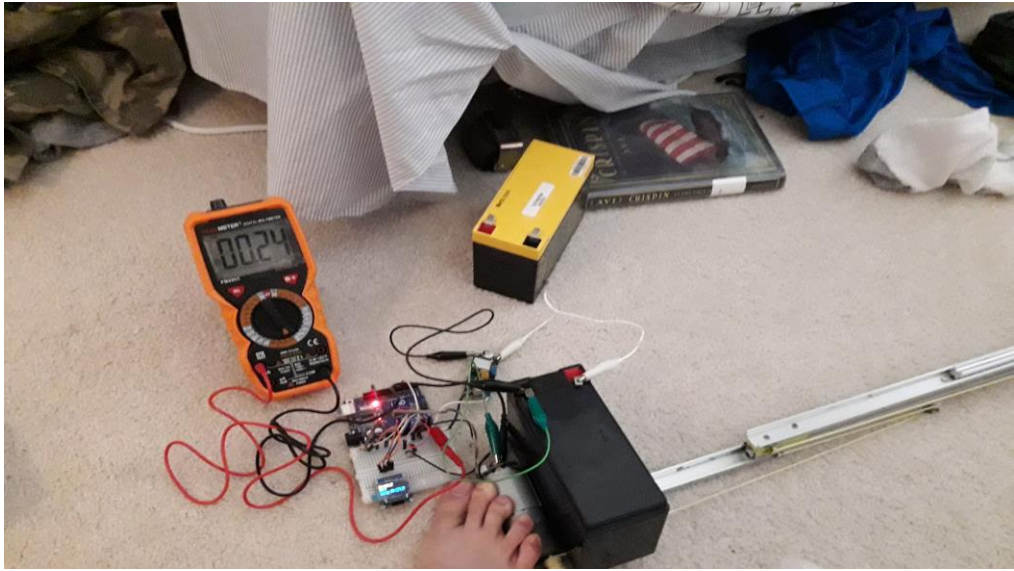
	Rev Continuous	Rev Cascade	Misumi Continuous	Misumi Cascade
Frictional Force (N)	.89	2.1	1.1	2.2
Friction Coefficient	.39	.85	.19	.38

Mass of Rev slide = 115g per slide

Mass of Misumi slide = 292g per slide

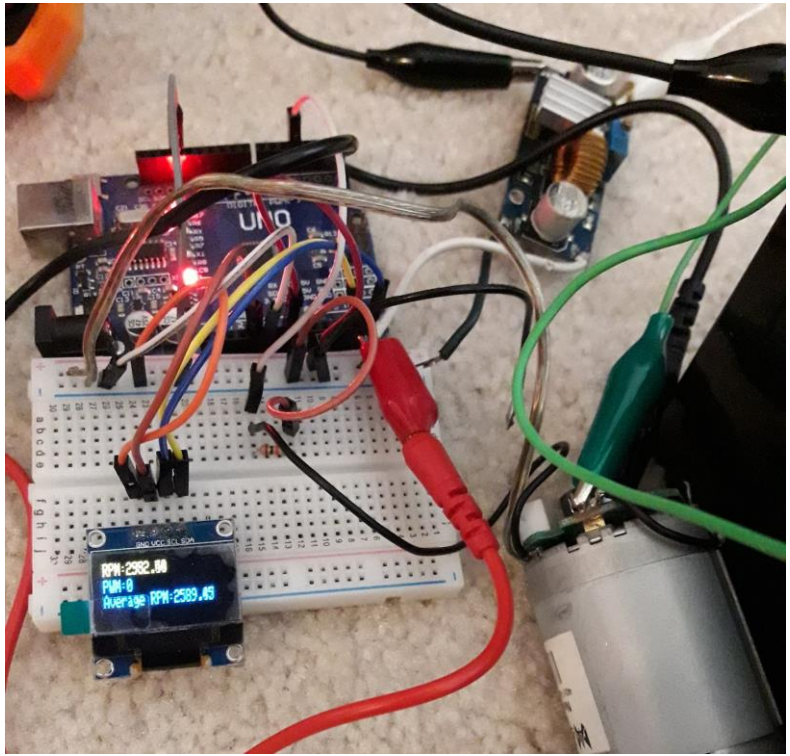
Setup

- Motor run at 5v instead of 12v for higher accuracy
- Each linear slide had 3 stages
- Length of fully extended Rev slide is 1.14 m
- Length of fully extended Misumi slide is 1.53m



Setup

- RPM measured using hall effect sensors
- Hall effect sensor output was detected using the Arduino pulseln() function which was converted into rpm
- Average rpm was calculated in real time using and approximation of the mean value theorem
- Current measured using a multimeter
- Constant voltage of 5v



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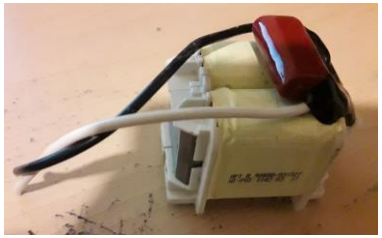
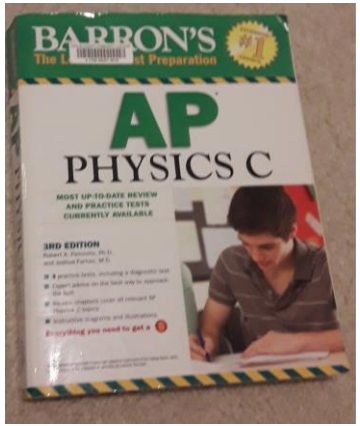
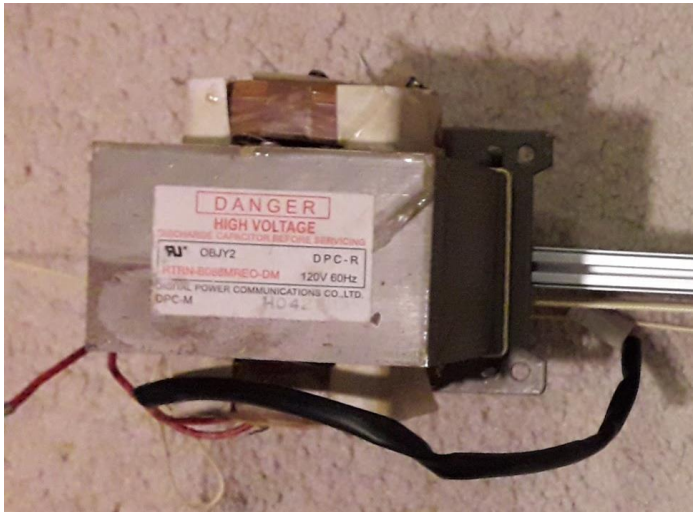
Various Loads



Small Inductor (282g)



Textbook (1083g)



Microwave Transformer (4058g)

Lead Acid Battery (2508g)

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Project Results

Rev Continuous Slide

	RPM	Time (sec)	Current (a)	Power (w)	Energy (j)	Tension (N)	Torque (N*m)
No load	2540	29	.22	1.1	31.9	.89	.003
Small Inductor (282g)	2379	34	.27	1.35	45.9	1.96	.007
Textbook (1083g)	2121	40	.40	2	80	5.02	.018
Lead Acid Battery (2508g)	1801	52	.77	3.85	200.2	10.48	.037
Microwave Transformer (4058g)	1242	68	1.26	6.3	428.4	16.41	.057

Rev Cascade Slide

	RPM	Time (sec)	Current (a)	Power (w)	Energy (j)	Tension (N)	Torque (N*m)
No load	2322	15	.22	1.1	16.5	2.08	.007
Small Inductor (282g)	1964	17	.31	1.55	26.35	4.44	.016
Textbook (1083g)	1801	21	.45	2.25	47.25	11.12	.039
Lead Acid Battery (2508g)	1684	29 -Stopped 2 inches from finish	.81	4.05	117.45	23	.08
Microwave Transformer (4058g)	Not tested						

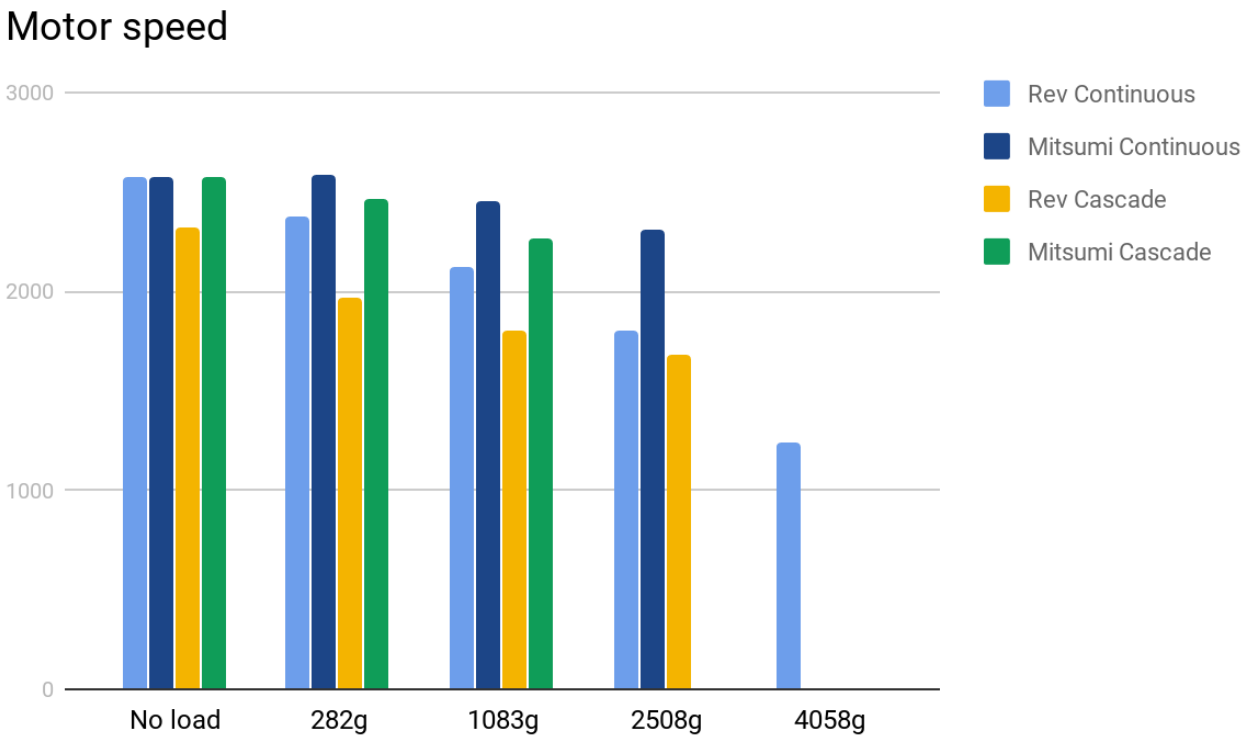
Misumi Continuous Slide

	RPM	Time (sec)	Current (a)	Power (w)	Energy (j)	Tension (N)	Torque (N*m)
No load	2576	33	.19	.95	31.35	1.36	.0048
Small Inductor (282g)	2588	34	.20	1	34	1.89	.0066
Textbook (1083g)	2451	38	.25	1.25	47.5	3.38	.0118
Lead Acid Battery (2508g)	2310	47* Only extended 2 slides	.48	2.4	112.8	6.04	.0211
Microwave Transformer (4058g)	Not tested						

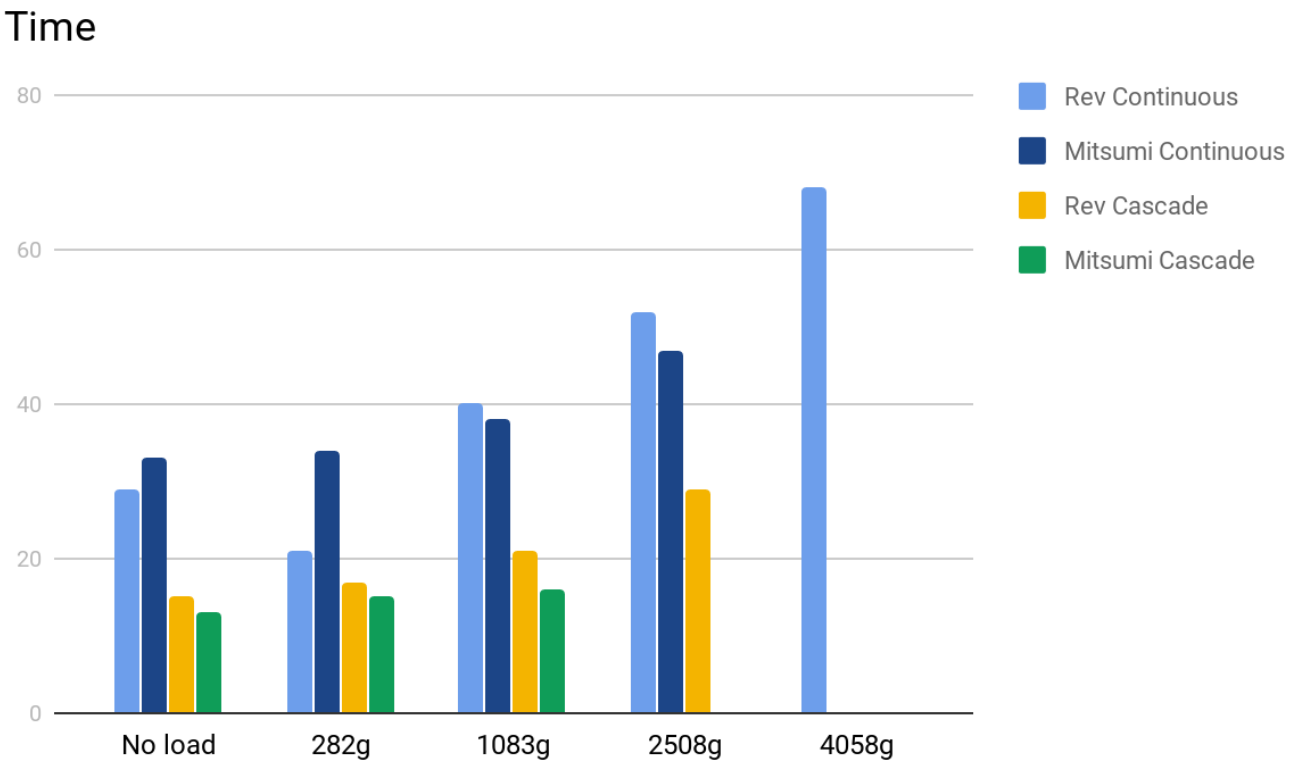
Misumi Cascade Slide

	RPM	Time (sec)	Current (a)	Power (w)	Energy (j)	Tension (N)	Torque (N*m)
No load	2572	13	.18	.9	11.7	2.72	.0095
Small Inductor (282g)	2468	15	.21	1.05	15.75	3.77	.0132
Textbook (1083g)	2269	16	.31	1.55	24.8	6.76	.0237
Lead Acid Battery (2508g)	Not tested						
Microwave Transformer (4058g)	Not tested						

Angular Velocity (RPM)

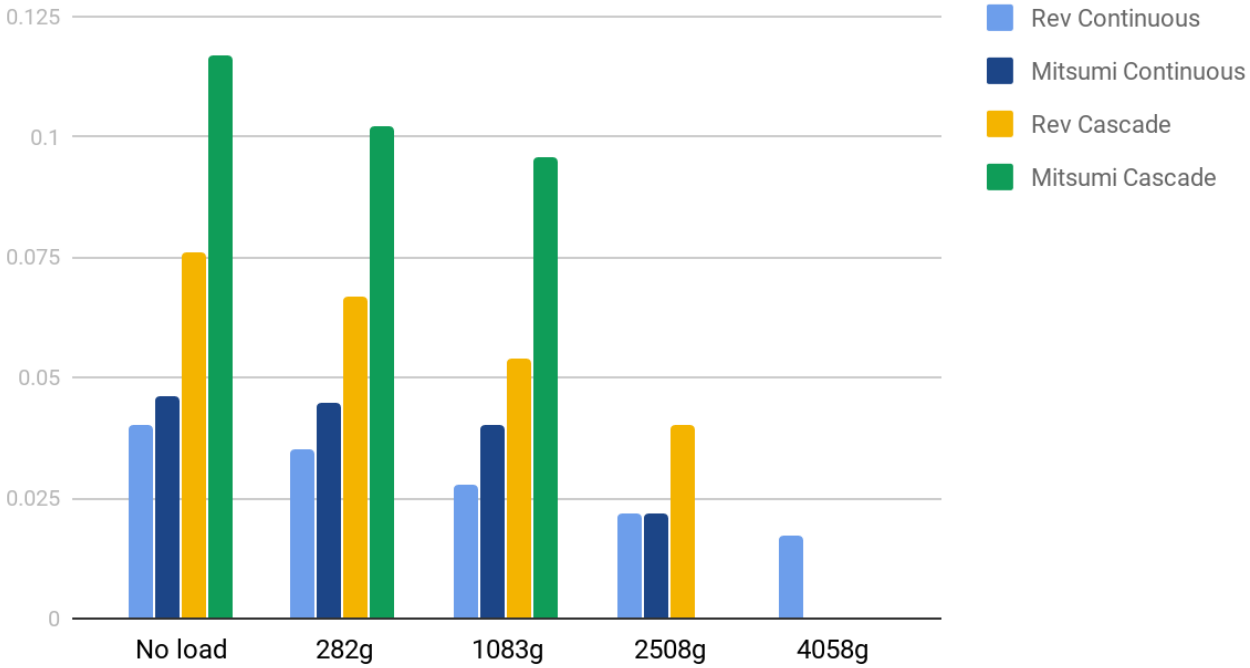


Time (sec)

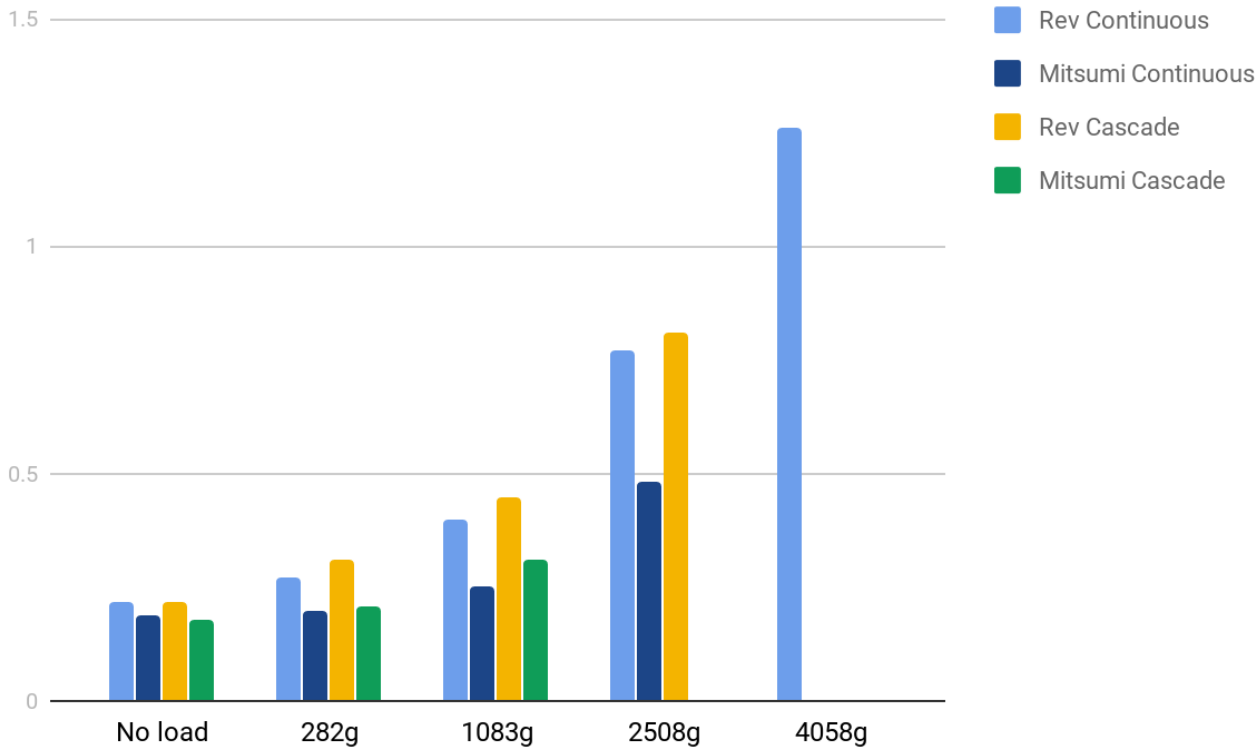

Time
80
60
40
20
0
No load
282g
1083g
2508g
4058g
Rev Continuous
Mitsumi Continuous
Rev Cascade
Mitsumi Cascade

Velocity (m/s)

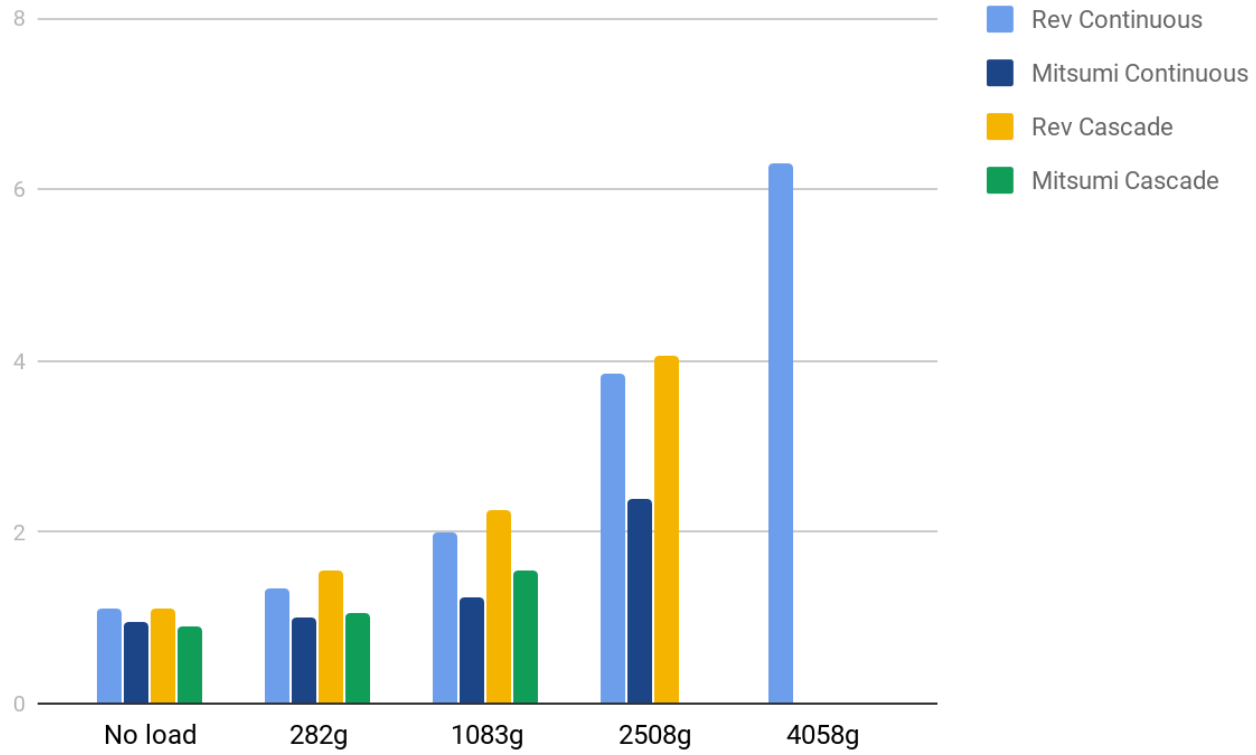
Linear Velocity



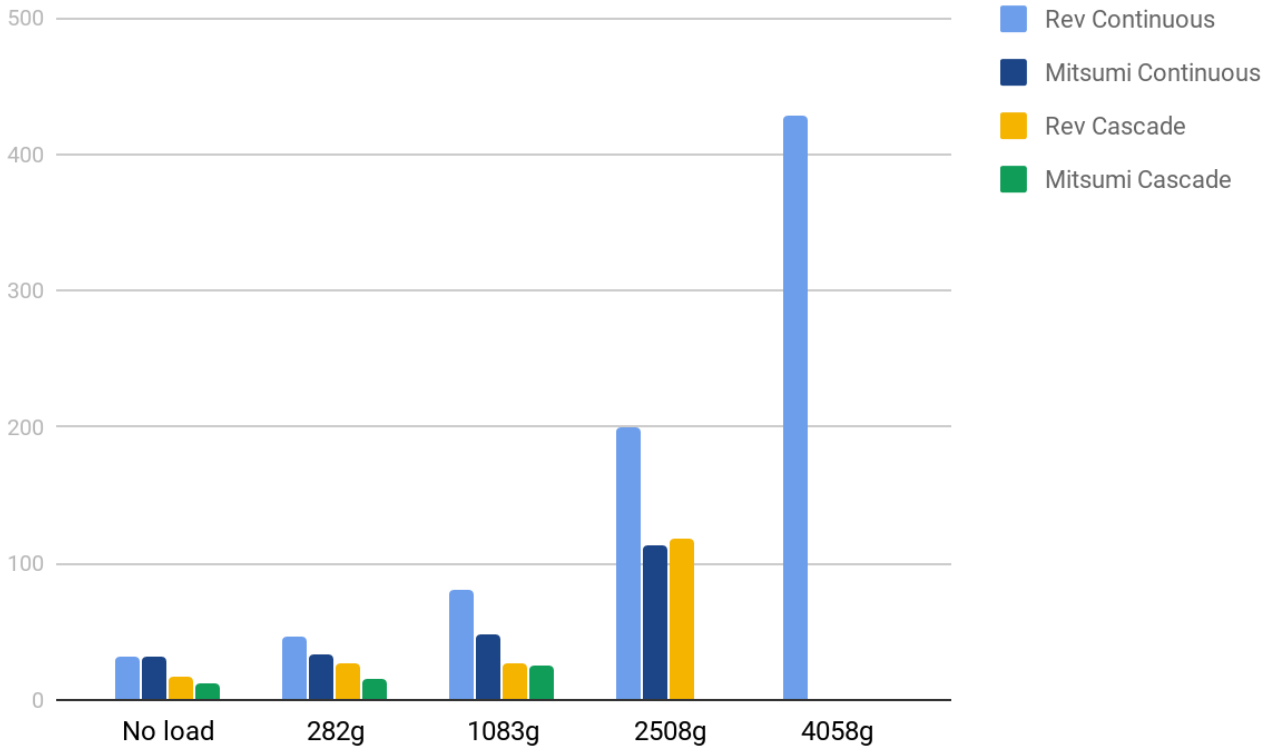
Current (amps)



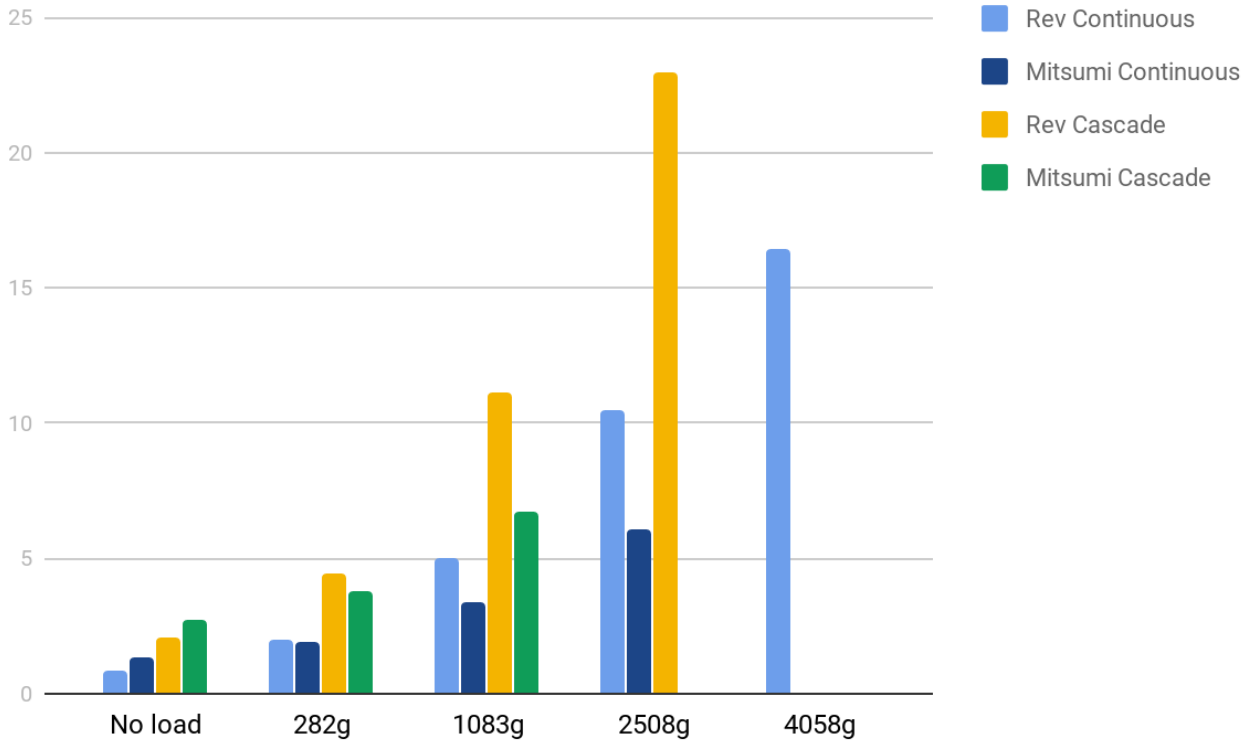
Power (watts)


8
6
4
2
0
No load
282g
1083g
2508g
4058g
Rev Continuous
Mitsumi Continuous
Rev Cascade
Mitsumi Cascade

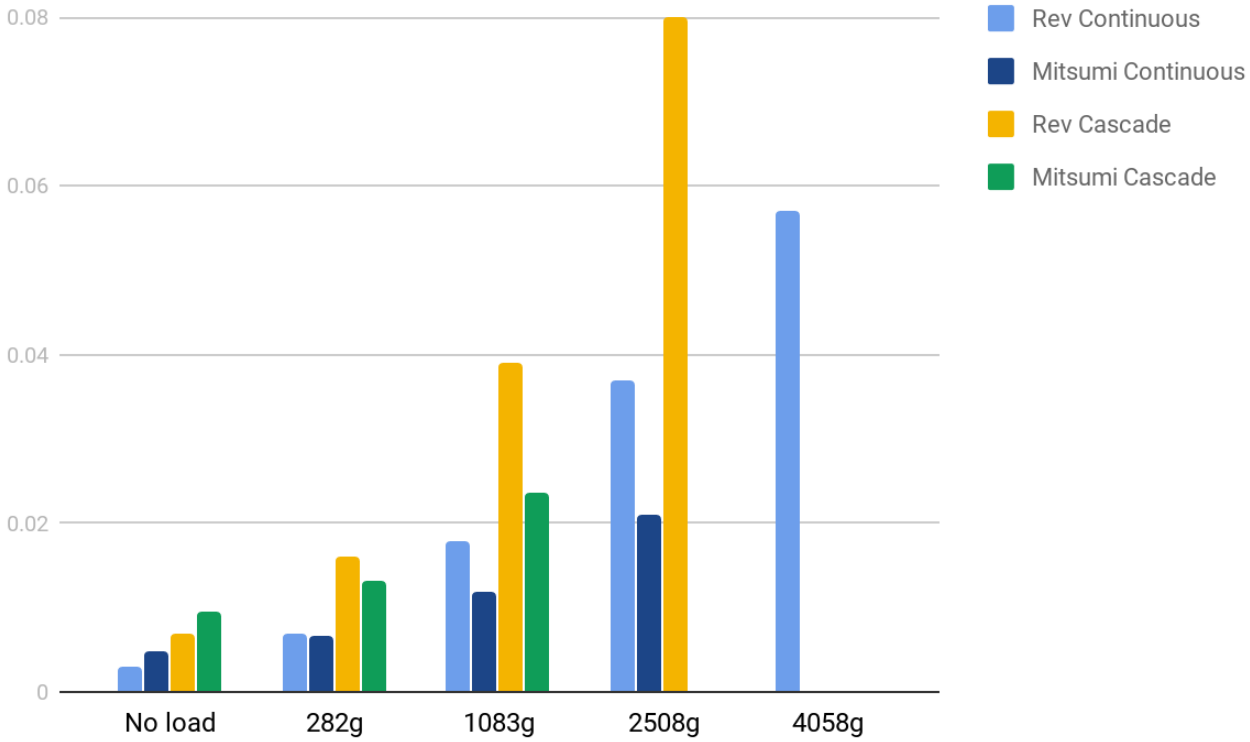
Energy Used (joules)



Tension (Newtons)



Torque (Newton Meters)



Conclusions

Conclusions

- 7172 mentioned a 4 stage cascade slide (as required in most FTC games) quadruple torque – I only tested 3 stage here with given materials
- Cascade slide would be ideal for applications with a small load and high motor power
- Continuous slide would be better for heavy lifting
- Misumi slides have much less friction, but are not as structurally strong
- REV slides are stronger but have much higher friction
- REV slides also have an issue where the plastic pieces that hold the slide together have imperfections that cause even more friction

Questions?