Executive Summary

Lab 4: System Analysis - Propulsion Efficiency

Written by

Tatry Group

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Submitted to

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Data

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio
grams	RPM	Watts	Watts	Horsepower	%	--
1.64	3413	0.58	0.06	7.56E-05	10.24	0.56
2.88	4191	0.89	0.10	#DIV/0!	9.00	0.46
4.11	4970	1.29	0.14	#DIV/0!	9.13	0.38
5.75	5677	1.76	0.20	#DIV/0!	8.92	0.34
7.40	6307	2.28	0.25	#DIV/0!	8.98	0.30
8.84	7111	2.80	0.30	#DIV/0!	9.23	0.27
10.69	7724	3.52	0.37	#DIV/0!	9.59	0.25
11.51	8383	4.19	0.39	#DIV/0!	10.62	0.23
11.92	9600	4.84	0.41	#DIV/0!	11.84	0.20

Table 1: propeller (pusher) EP-3020 data analysis

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio	Pusher	Puller
grams	RPM	Watts	Watts	Horsepower	%	--		
1.73	2335	0.56	0.06	7.94E-05	9.50	0.82	-98.75669	-94.12223
2.88	2934	0.89	0.10	1.32E-04	9.00	0.65	-57.04658	-57.04658
4.81	3652	1.31	0.16	2.21E-04	7.94	0.52	-40.36253	-34.70612
6.99	4311	1.81	0.24	3.21E-04	7.57	0.44	-29.23983	-24.33276
9.04	4970	2.43	0.31	4.16E-04	7.83	0.38	-23.06056	-19.12829
11.10	5688	3.06	0.38	5.10E-04	8.05	0.34	-19.53981	-15.8514
14.80	7399	4.55	0.51	6.81E-04	8.97	0.26	-16.40595	-12.24682
14.39	8411	4.60	0.49	6.62E-04	9.32	0.23	-15.33646	-12.55579
15.21	9100	5.46	0.52	6.99E-04	10.47	0.21	-14.85703	-11.95456

Table 2: propeller (puller) EP-3030 including propeller pusher and puller percent error

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio
grams	RPM	Watts	Watts	Horsepower	%	--
0.288	3113	0.311	0.010	1.32E-05	3.175	0.61
0.904	4071	0.548	0.031	4.16E-05	5.664	0.469
2.137	4970	0.851	0.073	9.83E-05	8.614	0.384
3.987	5928	1.221	0.137	1.83E-04	11.199	0.322
5.220	6826	1.658	0.179	2.40E-04	10.801	0.280
6.453	7724	2.161	0.221	2.97E-04	10.243	0.247
7.686	8562	2.664	0.264	3.54E-04	9.896	0.223
8.508	9341	3.219	0.292	3.91E-04	9.065	0.204
8.919	10119	3.785	0.306	4.10E-04	8.082	0.189
10.152	10838	4.396	0.348	4.67E-04	7.922	0.176

Table 3: propeller EP-3020(pusher) data analysis

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio	Pusher	Puller
grams	RPM	Watts	Watts	Horsepower	%	--		
0.411	2095	0.311	0.014	1.89E-05	22.047	0.911	-391.31649	-598.60003
0.986	2754	0.562	0.034	4.54E-05	16.623	0.693	-163.24718	-190.42515
2.178	3592	0.888	0.075	1.00E-04	11.885	0.531	-72.834325	-79.511686
4.110	4491	1.310	0.141	1.89E-04	9.291	0.425	-36.352287	-40.536339
5.754	5389	1.813	0.197	2.65E-04	9.186	0.354	-23.964457	-29.648204
8.220	6227	2.427	0.282	3.78E-04	8.609	0.307	-13.069538	-22.217469
9.864	7005	3.064	0.338	4.54E-04	9.055	0.273	-8.4855539	-16.775312
13.769	7844	4.551	0.472	6.33E-04	9.637	0.243	0.3320327	-13.942551
13.933	8622	4.599	0.478	6.41E-04	9.624	0.221	-0.0268643	-12.721225
14.385	9700	5.461	0.493	6.62E-04	11.068	0.197	0.83616441	-8.9583998

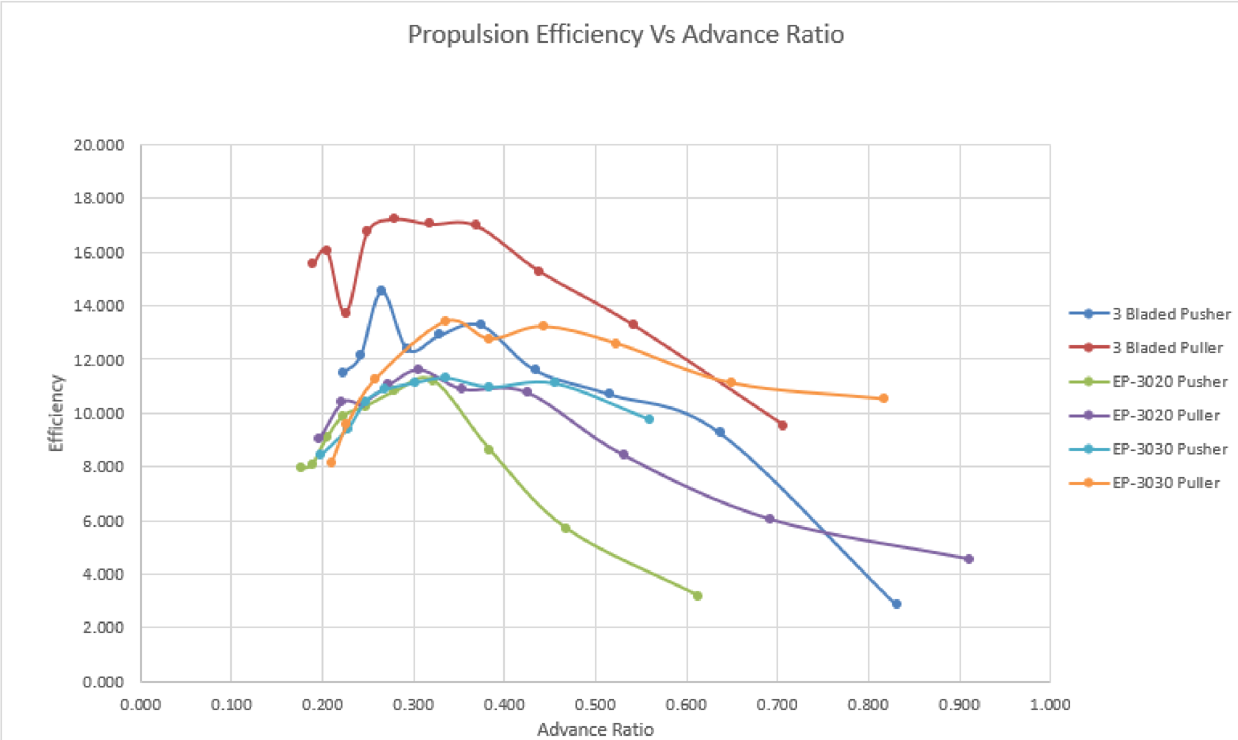
Table 4: propeller *EP-3020*(Puller) Including propeller pusher and puller percent error

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio
grams	RPM	Watts	Watts	Horsepower	%	--
0.247	2295	0.300	0.008	1.13E-05	2.822	0.832
1.480	2996	0.548	0.051	6.81E-05	9.268	0.637
2.713	3696	0.870	0.093	1.25E-04	10.701	0.517
4.357	4397	1.288	0.149	2.00E-04	11.605	0.434
6.823	5098	1.761	0.234	3.14E-04	13.287	0.374
8.919	5797	2.368	0.306	4.10E-04	12.919	0.329
10.933	6498	3.030	0.375	5.03E-04	12.375	0.294
15.865	7198	3.737	0.544	7.30E-04	14.561	0.265
16.276	7899	4.599	0.558	7.49E-04	12.138	0.242
18.166	8599	5.417	0.623	8.36E-04	11.503	0.222

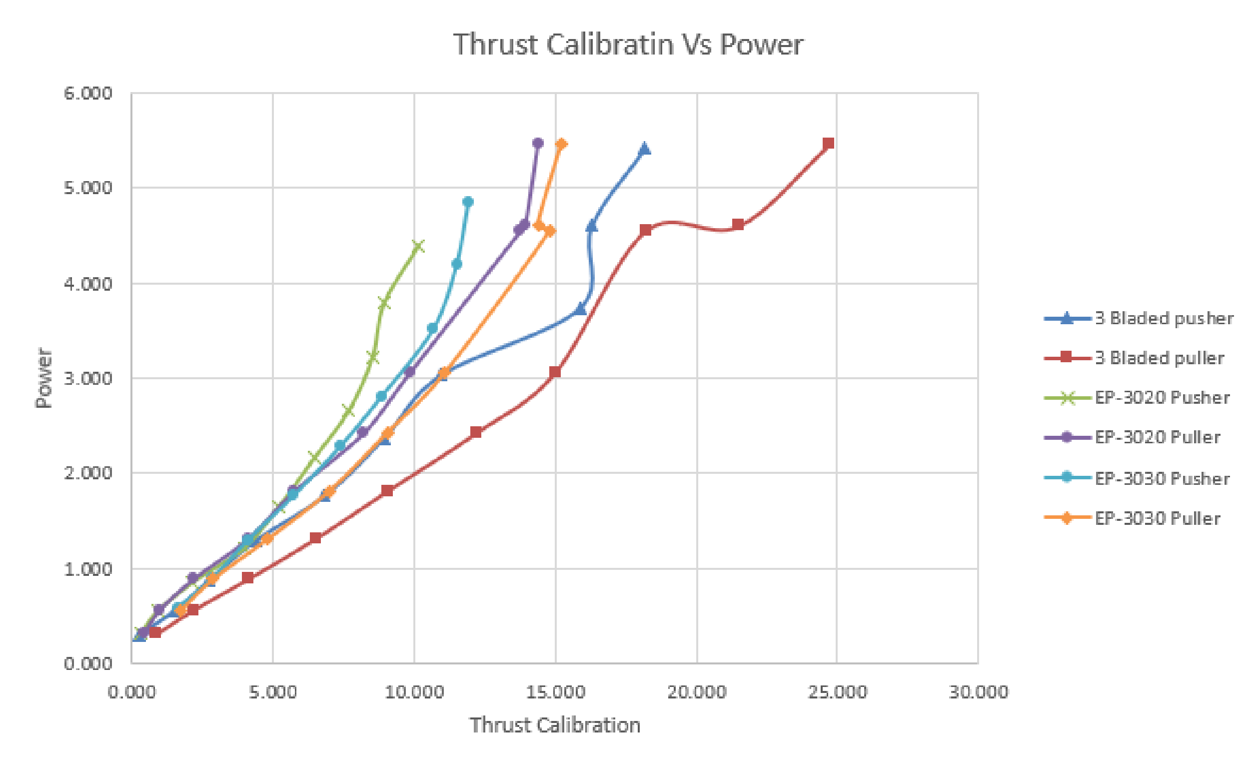
Table 5: EF-3 bladed propeller (Pusher) data analysis

Thrust Calibration	RPM	Power Input	Power Output	Power Output	Propulsion Efficiency	Advance Ratio	Pusher	Puller
grams	RPM	Watts	Watts	Horsepower	%	--	%	%
0.863	2700	0.311	0.030	3.97E-05	9.53	0.707	-650.20	-192.51
2.178	3524	0.562	0.075	1.00E-04	13.285	0.014	-107.33	-75.41
4.110	4348	0.888	0.141	1.89E-04	15.285	0.439	-57.75	-37.79
6.494	5172	1.310	0.223	2.99E-04	17.005	0.369	-33.98	-20.75
9.042	5996	1.813	0.310	4.16E-04	17.060	0.318	-18.24	-11.16
12.207	6820	2.427	0.419	5.61E-04	17.250	0.280	-10.93	-3.27
15.002	7644	3.064	0.515	6.90E-04	16.777	0.250	-5.72	1.90
18.207	8468	4.551	0.625	8.37E-04	13.722	0.225	4.08	7.04
21.495	9292	4.599	0.737	9.89E-04	16.031	0.205	4.05	11.67
24.742	10117	5.461	0.849	1.14E-03	15.540	0.189	7.16	15.88

Table 6: EF-3 bladed propeller (Puller) including EF-3 bladed propeller Pusher and Puller percent error



Graph 1: Data of Propulsion Efficiency vs Advance Ratio



Graph 2: Data of Thrust Calibration vs % power

Report

The lab helps in strategy and design. The reason for this is the objective of running experiments. These experiments give insight on how the mechanisms work. Having the ability to test equipment in a wind tunnel helps give necessary information. This information can be used to make modifications to the AEV design. These modifications will further improve the AEV's capabilities on the track. From Graph 2, it is shown that the three-bladed propeller has the most thrust power. Thus able to generate wind speed faster than the two-blade propeller. The three-blade propeller has a high puller power. The pusher power is not as high as the puller power. However, it still outclasses the other pusher and puller systems.

There is a difference between puller and pusher power. Both have different configurations when being tested. The puller (or tractor) configuration has the motor behind the propeller. The pusher configuration has the propeller behind the motor. It is important to note that recorded data for both is key. Having data for both systems allows room for design modifications. If one system performs better than the other, it is given that a modification should be made. However, these systems will vary depending on AEV design. If the AEV has a small compact system, then three-blade propellers would not be necessary as they would generate too much power. Thus the AEV does not have any control on the track. A small compact AEV design would utilize smaller propellers. Whether it's a puller(tractor) or pusher system is by choice.

As shown in the graph above(graph 1), the 3030 Puller blade has the most potent propulsion efficiency for the advanced ratio. It indicates that the blade has the most efficiency for a lower propellor speed, which is best for an efficient AEV. The objective of this lab was to collect data about different types of propellers using a wind tunnel. The lab was to analyze and examine what propeller would be the most efficient for the AEV and express or measure the propellers' characteristics. It helps to understand design functionality better and overall build the AEV with more efficiency.

Individually

Mati Desissa

- power input

$P_i = V * I * P_{\%}$
= (7.4)*(0.68)*(.35)
= 1.7612 w

- Power output

$P_o = T_c * V$

= 2.713g = 0.0266N
= (0.0266N)*(3.5m/s)
= 0.0931 w

- calibrated thrust

$T = 0.411 * (T - T_0)$
= 0.411*(200-160.4)
= 16.27 g

- advance ratio

$J = \frac{V}{(RPM/60)*D}$
$= \frac{3.5}{(\frac{2996}{60})*0.11}$
= 0.64 J

- propulsion efficiency

$\eta_{sys} = \frac{P_{in}}{P_{out}} * 100\%$
$= \frac{1.7612}{0.0931}$
= 18.92 %

- Error measurement

Error = $\frac{(T_c - T_m)}{T_c} * 100$
$= \frac{10.9 - 187}{10.9} * 100$
= -5.72 %

Gabe Bouahom

- Power Input

$P_{\text{in}} = V * I * P_{\%}$

= (7.4)*(0.68)*(.35)

= 1.7612 watts

- Power Output

$P_{out} = T_c * V$

= 2.713 g ---> 0.002713*9.8 m/s^2 = 0.0266 N

= (0.0266N)*(3.5m/s)
= 0.0931 watts

- Calibrated Thrust

$T = 0.411 * (T - T_0)$

= 0.411*(200-160.4)
= 16.27 grams

- Propulsion Efficiency

$\eta_{sys} = P_{out} / P_{in}$ x 100%

= (1.7612/0.0931) x 100%

= 18.91%

- Propeller Advance Ratio

$$J = \frac{V}{(RPM/60)*D}$$

$$=\frac{3.5}{(\frac{2996}{60})*0.11}$$

$$= 0.64 \text{ J}$$

Matthew Potts

- Calibrated Trust:

T_c =0.411*(T-T_0)

T_c =0.411*(161g-160.4g)

T_c =0.2466 grams

- Power Input:

P_{in}=V*I*$P_{\%}$

P_{in}=7.4v*0.27amps*.15

P_{in}=0.2997 Watts

- Power Output:

P_{out} =T_c *v

P_{out} =0.2466g*3.5m/s

P_{out} =0.8631 Watts

- Propulsion Efficiency:

n_{sys} =P_{out}/P_{in}*100%

n_{sys} =0.8631W/0.2997W*100%

n_{sys} =2.879%

- Propeller Advance Ratio:

J=v/((RPM/60)*D)

J=(3.5m/s)/((2295/60)*0.11

J=0.83 J

Work Division Statement:

Mati Desissa - Individual, some of the Report section, created the tables and graphs

Gabe Bouahom - Individual, most of the Report section

Matthew Potts - Individual