Non-Point Source Polluting Lawn Mower

THE UNIVERSITY OF MAINE

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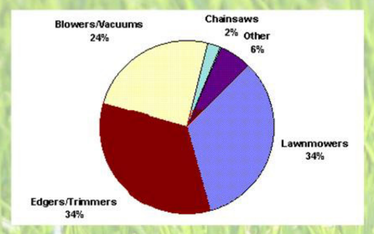
ENGINEERING

PROBLEM

Lawnmowers and other lawn care equipment are some of the biggest causes of pollution on the market. "Some older lawn mowers are bigger polluters than the family car," said James M. Lents, executive officer of Air Quality Management District in Orange County California. "A dirty mower operated for 20 hours a year producers the same amount of smog-forming volatile organic compound pollution as a 1996 passenger car driven for 26,000 miles – more than most people drive in a year."
(http://www.aqmd.gov/news/scrap1.html)



(http://www.umaine.edu/mecheng/Peterson/Classes/Design/2005_6/Initial/Prog1.htm)

Eric Landis, an Engineering Professor at University of Maine, donated an electric lawnmower that was no longer running properly to the project. The lawnmower would initially mow short, dry grass for a period of approximately 40 minutes. Wet long grass would drain the batteries in a 10-15 minutes. When we received the mower it failed to start. After rewiring the mower we were able to mow grass for 5 minutes before the batteries were noticeable drained.

Objective

This project strives to find a suitable power alternative for a lawn mower which will have satisfactory performance without emitting the large amount of pollution produced by a gas driven mower.

- Substantial reduction in pollution emissions
- Suitable power to cut a typical residential lawn

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Power Choices

Power Source	Weight	Fuel Cell	Solar	Battery	Biofuel
Initial Cost	7	1	2	3	4
Point Source Pollutants	10	3	4	4	1
Power	5	3	1	2	4
Weight	3	1	2	3	4
Mow Time	9	3	1	2	4
Fuel Storage	2	1	3	4	2
Fuel Accessibilty	6	1	3	4	2
Total		90	98	130	122

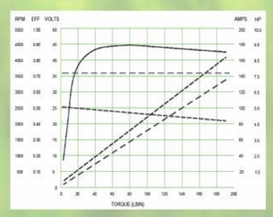
Battery Choices

Battery	Weight	Nickel Cadmium	Nickel Metal Hydride	Lithiumlon	Lithiumlon Polymer	Lead Acid
Life Expectancy	9	5	3	3	3	2
Charge Time	7	5	4	4	4	2
Cost (7.2V)	10	3	2	1	1	5
Energy Density	2	2	3	5	4	1
Toxicity	4	1	3	5	5	1
Memory	8	2	1	5	5	5
Overcharge Tolerance	5	3	2	1	2	5
Self - Discharge/month	3	2	1	4	4	5
Additional Performance	6	5	2	1	1	4
Total		185	126	158	161	192

Motor Choices

Motor	Power	Price	Voltage	RPM	Weight	Amps	Effeciency
General Electric Model 5BT1344B133	2HP	$200	24V	1050	149	72	82%
Briggs and Stratton ETEK	15HP	$350	12-50V	3500	20.8	180	90%
PERM PMG132	34.3HP	$650	24-72V	3500	24.8	110	88%
PERM PMG080	3.95HP	$485	12-24V	6880	7.5	78	83.20%
AST-789-6 Military Surplus	5HP	$200	28V	4500	53	140	82%
Jack & Heintz AST-639-6	10HP	$360	30V	4000	80	?	?
Leeson AST-9112-01	1.5HP	$240	24V	1800	32	62	?

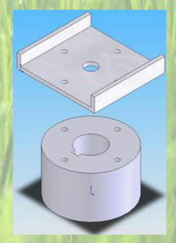
The Briggs and Stratton ETEK motor was chosen because it is light weight, outputs high power, and has a very good efficiency, even at high torques. The solid black line on the following graph shows an efficiency vs. torque graph of the ETEK motor at 36 volts.



(http://www.robotcombat.com/marketplace_etek.html)

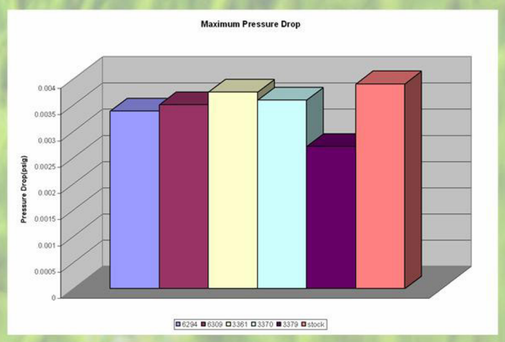
Blade Attachment

With the purchase of a new motor, a new blade attachment needed to be fabricated. A cylinder with a keyway was created to connect to the output shaft of the motor. A flat plate held with screws attached the blade to this. A bolt was threaded through the blade, plat, and cylinder to secure it all to the output shaft.



Blade Selection

Six new blades were purchased of varying width and airfoil design. With a spare mower chassis, eight holes were drilled at increasing distances from the center of the blade. Each blade was attached and the pressures at each hole was measured. This gave us a pressure profile of the blade in rotation. The blade with the minimum pressure drop between measured locations would be the blade with the lowest losses due to the "fan effect".



Final Upgrades

- Increase Voltage (24V → 36V)
- Increase Battery Capacity (17.2 Amp-Hour → 21 Amp-Hours)
- More Efficient Motor
- Removable Battery Pack (Lead Acid)
- Blade with reduced losses pressure characteristics