FULL SIZE E-CAR REPORT

12/04/97

DESIGN

Designed and built by our B*E*S*T [Bridging Engineers, Science and Teaching] team at Lee Hart's house on Nov. 2 and 6 using a wooden box, two bicycles, chair, motor, battery and aluminum structural material. Additional tasks carried out at Bob Aske's house on Nov. 7 - 30 were as follows:-

- Prepared E-Car Drawing [attached]
- Determined E-Car Weight Breakdown
- Added Brake Mechanism
- Replaced Chair for ease of entry [Ergonomics]
- Added Go-Switch, Fwd/Bkwd Switch, Amp Meter and second Battery
- Conducted Tests on the Motor and E-Car

TESTS

MOTOR [Yaswaka Electric; 5.7 amp @ 28 VDC; 2500 RPM]

Load	Voltage	Current (amp)	RPM
Low	12	2.4	1000
Medium	12	5.4	500
High	12	10	Near zero
Low	24	5	--------
Medium	24	15	800 - 1000
High	24	20	Near zero

E-CAR [with 40 psig tires @ 27 - 42F ambient conditions]

Total Weight (lb)		Voltage	Current (amp)	Velocity (mph)	Motor RPM
103 + 0 =	103	12		5.7	750
103 + 191 =	294	12		3.4	450
129 + 191 =	320	24	25 start / 15 - 17	5.4	710
129 + 191 =	320	24	25 start / 15	6.0	810
129 + 103 =	232	24		6.8	900
129 + 103 =	232	24		7.6	1000
129 + 191 =	320	24		6.8	900
129 + 191 =	320	24		7.6	1000

FUTURE EFFORTS

- **B*E*S*T Team Should Name the E-Car**
- **Try Smaller Pulley as suggested by Clarence Ogburn**
- **Add Second Motor with different Drive [Direct Drive fails in Snow]?**
- **Visit the Schools?**

Robert L. Aske

February 5, 1998 **cc:-** **5th Grade Class at Armatage**

To:- **Greg Gustafson - Technical Education Center, Honeywell Inc.**

From:- **Robert L. Aske - Mechanical Engineer Consultant at Armatage**

Subject:- **Model E-Car Contest Results at Armatage School**

INTRODUCTION

The Armatage 5th Grade class was divided into four (4) teams as follows:-

Team 1	Team 2	Team 3	Team 4
Jama	Sierra	Amir	Sadia
Megan	Marie	Emily	Jeremie
Jessica	Elizabeth	Vanessa	Maureen
Ben	Adam	Fardowsa	Amy
Ashley	Meng	JJ (Jackson)	Paochoua

Each team, designed, fabricated and tested their model E-Car in preparation for a contest which evaluated (1) speed, (2) aerodynamics, (3) lightest weight and (4) most artistic design. The four E-Cars and students in the contest are shown in the attached photographs.

RESULTS

Racing time trials were held on a 20 - ft. long track on January 14 with results as follows:-

Team 1 E-Car:-	**Time = 6.25**	**seconds;**	**Velocity = 20/6.25**	**= 3.2fps = 2.2mph**
Team 2 E-Car:-	**Time = 15.0**	**seconds;**	**Velocity = 20/15.0**	**= 1.3fps = 1.0mph**
Team 3 E-Car:-	**Time = 10.0**	**seconds;**	**Velocity = 20/10.0**	**= 2.0fps = 1.4mph**
Team 4 E-Car:-	**Time = 15.0**	**seconds;**	**Velocity = 20/15.0**	**= 1.3fps = 1.0mph**

Team 2 and Team 4 tied for 3rd place and these two E-Cars raced each other for 3rd place; Team 2's E-Car won!

In summary, all the E-Cars were winners as the table below shows!!!! All the students were awarded with a **Certificate of Recognition** (attached) which qualifies each of them to participate in the design and fabrication of a full size Electric Car starting on February 5, 1998. Speed, Maneuverability and Endurance contests between each school and class participating in the E-Car program are scheduled to occur at Armstrong High School on May 16, 1998.

Team	Speed	Aerodynamics	Lightest Weight	Artistic Design
1	WINNER			
2		WINNER		
3			WINNER	
4				WINNER

1 - MOTOR DEFINITION:-

YASWAKA ELECTRIC (JAPAN)
JKPM-16 ZF
28 VDC 5.7 AMP
2500 RPM
PULLEY DIA = 2.5" DRIVING 20" OD WHEEL

2 - WEIGHT SUMMARY:-

MISCELLANEOUS (NOTE 3)	1.5	LB
BOX FRAME	21	LB
MOTOR MOUNT BOARD	3	LB
ALUMINUM L CHANNEL (2)	7	LB
STEERING FORK ASSEMBLY	7	LB
CHAIR	8	LB
BRAKE MECHANISM	3	LB
BATTERY (2)	61	LB
FRONT WHEEL	3	LB
REAR WHEEL (2)	8	LB
MOTOR & PULLEY	6.5	LB
TOTAL	129	LB

3 - MISCELLANEOUS INCLUDES:-

FASTENERS
CONTROL PANEL (FRWD / BKWD SW & AMP METER)
GO-SWITCH
WIRING

BOX FRAME [24" X 36" X 10"]	BRAKE MECHANISM
MOTOR MOUNT BOARD	CHAIR
ALUMINUM L CHANNEL (2)	STEERING FORK ASSEMBLY
BATTERY (2)	GO-SWITCH
FRONT WHEEL	CONTROL PANEL
REAR WHEEL (2)	MOTOR & PULLEY

Robert L. Aske

February 19, 1998

cc:- **5th Grade Class at Armatage**
Paul Patton - MN10-2499
Jerry Hagen - HRVP
Teachers & Engineers

To:- **Greg Gustafson - Technical Education Center, Honeywell Inc.**

From:- **Robert L. Aske - Mechanical Engineer Consultant at Armatage School**

Subject:- **E-CAR ELECTRIC MOTOR TESTS**

INTRODUCTION

Rick Cash provided me with a 12 volt, 12 amp motor purchased for $10.00 at Ambles Machinery Hardware & Steel Co. [2109 Cedar Ave So., Mpls.,MN (332-0300)]. The motor is made by Simer Pump Co. [5960 Main St. N., Mpls., MN 55432]. It is a permanent magnet type 12 Volt DC 12 Amp. motor. The motor shaft turns clockwise (CW) when facing the shaft with the red wire connected to the (+) terminal of the 12 VDC battery. The shaft turns CCW with the black wire connected to the (+) terminal. The motor was evaluated in my laboratory for input and output power under various loads [torque]. This was done using the rear wheel assembly of a Huffy bicycle. A 1.75" pulley was attached to the 5/16" diameter motor shaft. The motor was mounted so the 1.75" diameter pulley would drive the 20" diameter wheel. Torque was applied to the wheel using the coaster brake. The spin rate of the wheel was estimated by counting the number of revolutions in a measured time interval.

RESULTS

Test results are summarized below:-

Wheel	Wheel	Motor	Motor	Output Power		Input Power				Efficiency
Torque	Spin	Torque	Spin	ft-lb/s	HP	Amperes	Volts	Watts	HP	(Output / Input)
0.0 lb-ft	5.00 rps	0.000 lb-ft	57 rps	0	0	7	12	84	0.113	0
2.5 lb-ft	4.00 rps	0.219 lb-ft	46 rps	62.8	0.114	12	12	144	0.193	59%
5.0 lb-ft	4.00 rps	0.438 lb-ft	46 rps	125.6	0.228	15	12	180	0.241	95%
7.5 lb-ft	3.33 rps	0.656 lb-ft	38 rps	156.8	0.285	20	12	240	0.322	89%
10. lb-ft	0 nil	0.875 lb-ft	0 nil	0	0	30	12	360	0.483	0

CONCLUSIONS

I believe Rick Cash made an excellent choice in the selection of this particular motor for the E-Cars! Based on tests done on our Engineer / Teacher E-Car, I believe speeds above 10 mph are achievable with this motor. My assumptions are:-

- E-Car weight = 100 lb.
- Student weight = 100 lb.
- Rolling friction = .04x[100 + 100] = 8.0 lb
- Aerodynamic drag = 1.0 lb [@ 10 mph]
- Grade = Straight and level

Wheel (20" dia) Torque = (8.0 + 1.0)(10/12) = 7.5 lb-ft which provides for a spin rate of approximately (see table, above) 3.33 rps.
E-Car Speed = (3.1416)(20/12)(3.33) = 17.4 fps = 11.9 mph.