Project Formulation and Plan for the Shell Eco-Marathon Competition

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Overview

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Overview

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Introduction

- Background info on Eco-Marathon
  - 1939 - Competition started from wager between 2 Shell engineers
  - 1977 - First International competition in UK
  - 2004 - Record for highest fuel economy (8000 mpg)
  - 2007 - First competition in the Americas
  - 2010 - First competition in Asia

Need Statement

- Due to sufficient number of vehicles running on finite resources as a means of transportation, it has become necessary to research and develop means to stretch those finite resources further. The Shell Corporation has sponsored a competition to promote this research and development.

Goal

- The team’s goal for this semester is to accurately and appropriately design an internal combustion engine powered vehicle for the Shell Eco-Marathon Competition that will have several subsystems working together to reach a fuel efficiency of at least 500 mpg.

Objective

- Design ignition, propulsion, braking, and electrical systems for a vehicle that will safely:
  - Start-up and engine at desired rpm within 5 seconds
  - Achieve a maximum average speed of 17mph
  - Stop the vehicle within 50ft from a speed of 17mph
  - Hold a vehicle stationary on a 20% incline
  - Completely shut down all vehicle systems within 1 second

Operating Environment

- Design Environment
  - The design environment will take form in weekly team and group meetings in the NAU Engineering Building to ensure accuracy within the vehicle design
- Fabrication Environment
  - The team will build/fabricate the designed vehicle in the student projects shop on NAU campus and perform initial testing around the campus
  - The driver will also gain experience with driving the vehicle and operating the vehicle systems

Operating Environment

- Tuning Environment
  - The initial tuning will be done in Flagstaff for engine break in and preliminary testing
  - The vehicle will also be tuned and tested in Phoenix before the competition to obtain a better idea of potential results due to the lower elevation (1200 ft above sea level)
- Competition Environment
  - The competition will take place in downtown Houston,TX from April 25th to the 27th
  - Practice, tuning, competition, and presentation will take place

Drivetrain (Clutch & Transmission) Constraints:

- Effective transmission chain or belt guard(s):
  - To protect driver or technician
  - Made of metal or composite material
  - Rigid enough to withstand a break
- Clutch system must be equipped, with the internal combustion engines

Drivetrain (Clutch & Transmission) Constraints:

- Manual Clutch:
  - Must not have the starter motor operable with the clutch engaged.
- Automatic clutch:
  - Motor starting speed below speed engagement of the clutch.

Braking Constraints

- 2 Independent Systems
  - Front Wheel(s)
  - Rear Wheel(s)
- All wheels must have braking force applied
- Simultaneous Engagement
- Needs to stop vehicle from 17mph within 50ft
- Needs to hold vehicle stationary at 20% incline

Fuel System Constraints

- Fuel must be Shell Regular Gasoline (87) or E100 (100% Ethanol)
- Fuel tank must be APAVE certified and a volume of either 30,100,or 250 cc
- Fuel tank must be mounted in a zero degree position and at least 5cm below the roll bar
- Air Intake must not contain any fuel or blowby gas

Fuel System Constraints

- Internal and external emergency shut-down systems must shutdown the ignition and fuel supply
- External system must be permanently mounted to body
- External system must have a latching red push button and be labeled with a 10cm by 3cm wide red arrow on a white background·
- Fuel line between tank and engine may not contain any other elements

Fuel System Constraints

- Fuel lines must be flexible and clear in color and not prone to expansion
- Teams cannot increase or decrease the fuel temperature
- Float chambers must include a drain valve at the bottom of the carburetor to ensure fuel level goes down in the fuel tank

Electrical System Constraints

- Maximum on-board voltage must not exceed 48V nominal
- Only one on-board battery and the battery must maintain a constant ground
- Electrical circuits must be protected from short circuit and overload
- Electric horn must be 85 dBa and pitch of 420 Hz

Electrical System Constraints

- Electrical starter can only operate when ignition and fuel systems are activated
- Electrical starter must not provide propulsion
- A red starter light must be installed on the rear of the vehicle with a luminescence of 21W and be clearly visible from both sides
- Starter and starter light must be extinguished by the time the rear wheel crosses the start line

Technical Documentation Constraints

- Fuel System
  - Full description and detailed schematic from tank to motor
    - including pressurized air bottle, pressure relief valves, air pressure gauges, fuel tank, valves, injectors, float chambers, and pumps
  - Description of vehicle clutch operation
    - Specifically showing starter motor does not engage clutch

Technical Documentation Constraints

- Electrical System
  - Circuit diagrams with all components listing voltage, current, and power ratings
    - Show emergency stop switch locations for inside and outside of car
    - Show battery location with type and rated voltage
    - Show starter motor location
- All documentation must be current, printed copies, with display poster

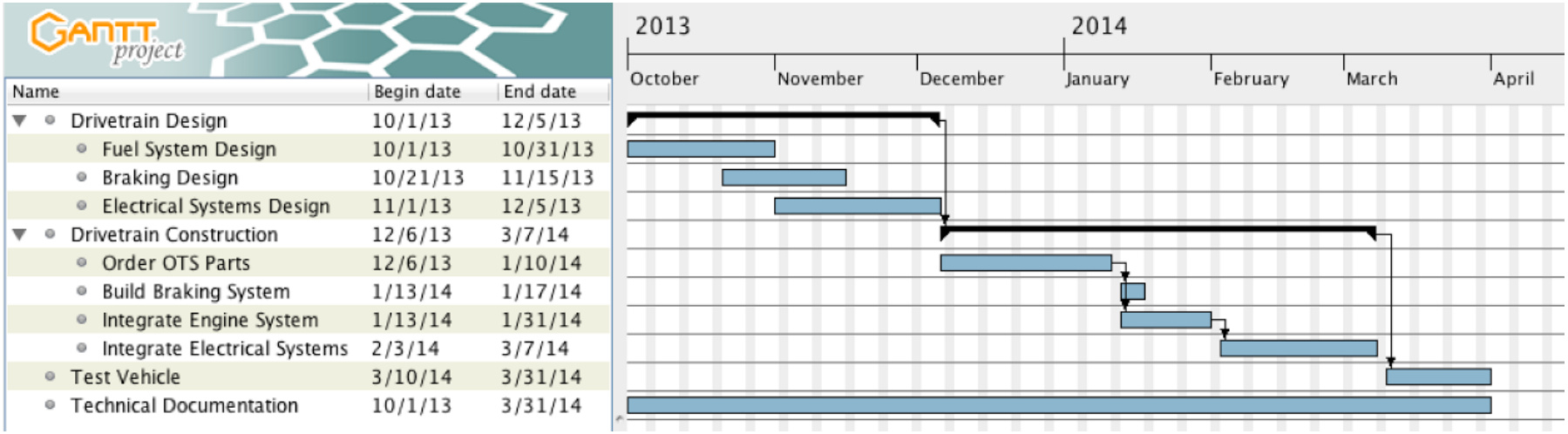
Planning

- Independent Research
- Systems Design and Integration
- Ordering/Fabricating Parts
- Assembly
- Initial Tuning and Engine Break-in
- Fine Tuning
- Competition

Quality Function Deployment (QFD)

			Maximum Efficiency Vehicle								
			Requirements								
	Customer Needs	**Customer Weights**	**Accesibility**	**Part strength**	**Horse Power**	**Torque**	**Weight**	**Velocity**	**Friction**	**Steering geometry**	**Gear Ratio**
Drive	Maintain average lap time	7	0	1	8	6	10	5	2	1	7
	Complete course efficiently	10	0	1	9	6	10	6	6	1	10
	Manuever course	7	0	3	6	8	7	8	8	10	5
Braking	Braking distance	6	0	5	0	0	8	0	10	0	0
Safety	Operate safely	6	10	10	1	3	1	0	0	0	0
	Be stable	5	0	8	0	3	8	4	7	3	0
		Raw score	60	168	194	191	313	171	225	102	184
		Relative Weight	4%	10%	12%	12%	19%	11%	14%	6%	11%
	*U.L. ; Stands for unitless	**Unit of Measure**	s	psi	hp	lbf	lb	fps	U.L.*	U.L.*	U.L.*

Gantt Chart


GANTT project
Name
Begin date
End date
Drivetrain Design 10/1/13 12/5/13
Fuel System Design 10/1/13 10/31/13
Braking Design 10/21/13 11/15/13
Electrical Systems Design 11/1/13 12/5/13
Drivetrain Construction 12/6/13 3/7/14
Order OTS Parts 12/6/13 1/10/14
Build Braking System 1/13/14 1/17/14
Integrate Engine System 1/13/14 1/31/14
Integrate Electrical Systems 2/3/14 3/7/14
Test Vehicle 3/10/14 3/31/14
Technical Documentation 10/1/13 3/31/14
2013
2014
October
November
December
January
February
March
April

Conclusion

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- Need Statement
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Questions?

References

Shell Eco-marathon, "Offical Rules 2014 Chapter 1,"http://s01.static-shell.com/content/dam/shell-new/local/corporate/ecomarathon/downloads/pdf/sem-global-official-rules-chapter-1-2014.pdf, 01 Oct. 2013.