Shell Eco-Marathon

Concept Generation and Selection

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Overview

- Project Overview
- Braking Concepts
- Drivetrain Concepts
- Engine Concepts
- Fuel System Concepts
- Electrical System Concepts
- Final Concept Design
- Conclusion

Project Overview

Need

- High volume greenhouse gas emissions from vehicles contribute to global warming

Goal

- Design, build, and compete with a vehicle prototype that maximizes high fuel efficiency.
- Focus on drivetrain, engine, brakes, fuel system and electrical

Braking Concepts

- Disk
- Caliper
- Drum

Disk Brakes

http://upload.wikimedia.org/wikipedia/commons/2/21/BrakeDiskVR.JPG

Disk Brakes

- Advantages
  - Lightweight
  - Have good stopping advantages
- Disadvantages
  - More expensive

Caliper Brakes

http://roadcyclinguk.com/wp-content/uploads/old_images/news/images/kcnc-brake-hi.jpg

Caliper Brakes

- Advantages
  - Very simple
  - Inexpensive
- Disadvantages
  - Easy to get clogged with debris

Drum Brakes

http://www.ecovelo.info/images/roller.jpg

Drum Brakes

- Advantages
  - Inexpensive
  - Very low maintenance
- Disadvantages
  - Doesn’t dissipate heat well

Braking Decision Matrix

	Relative Weight	Disk	Caliper	Drum
Weight	30%	10	10	1
Reliability	30%	10	1	1
Simplicity	10%	10	10	5
Cost	30%	5	10	5
Total	100%	8.5	7.3	2.6

Final verdict: Disk brakes

Drivetrain Selection

The way of delivering the torque coming from the engine to the rear wheel can helps us to achieve high fuel efficiency.

There are three types of possible drivetrain systems:

- Shaft & gearbox drivetrain
- CVT belt system
- Roller chain & sprocket drivetrain

Drivetrain Selection

Shaft & Gearbox Drivetrain:

- Can be seen in most cars.
- best method of delivering highest torque from the engine to the wheel
- More weight will be added to the vehicle if this drivetrain is used
- Very reliable drivetrain

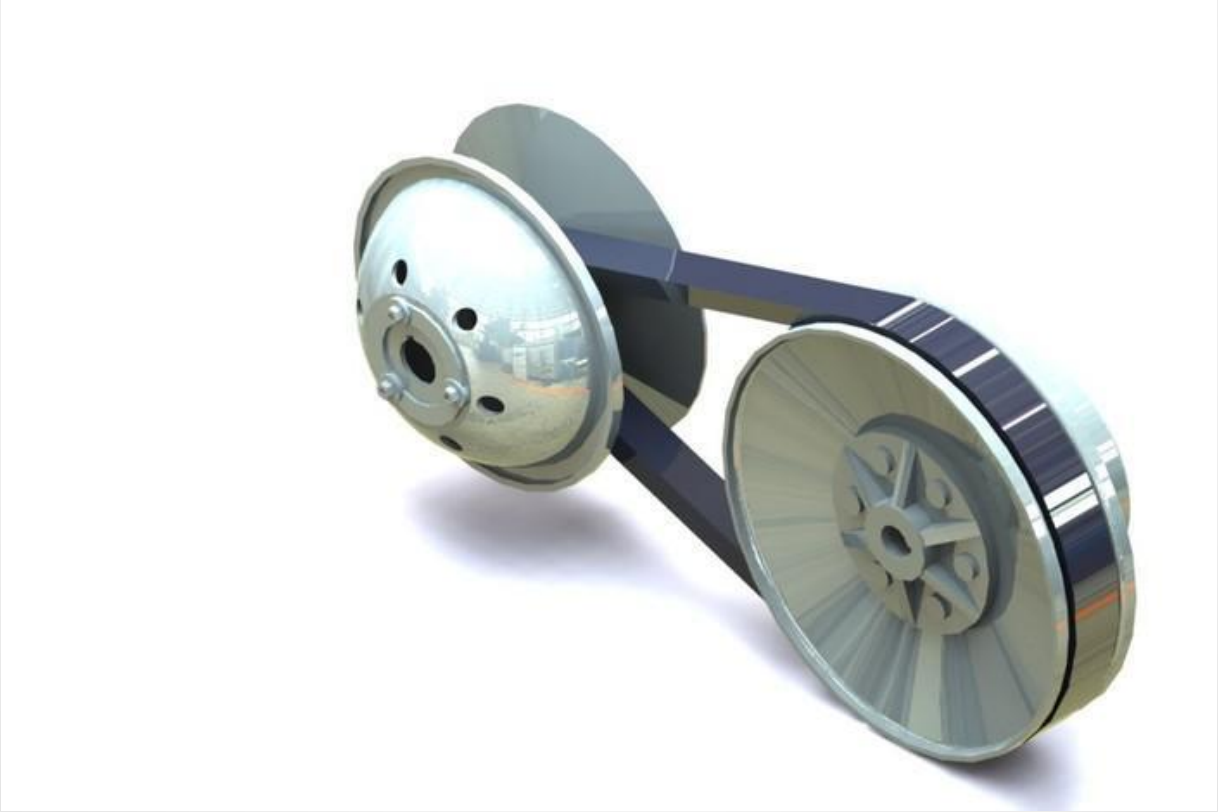
Drivetrain Selection

CVT Belt System:

- Gear ratio
- More weight
- Deliver required Torque

Drivetrain Selection

CVT Belt System:



https://grabcad.com/library/cvt-comett-780

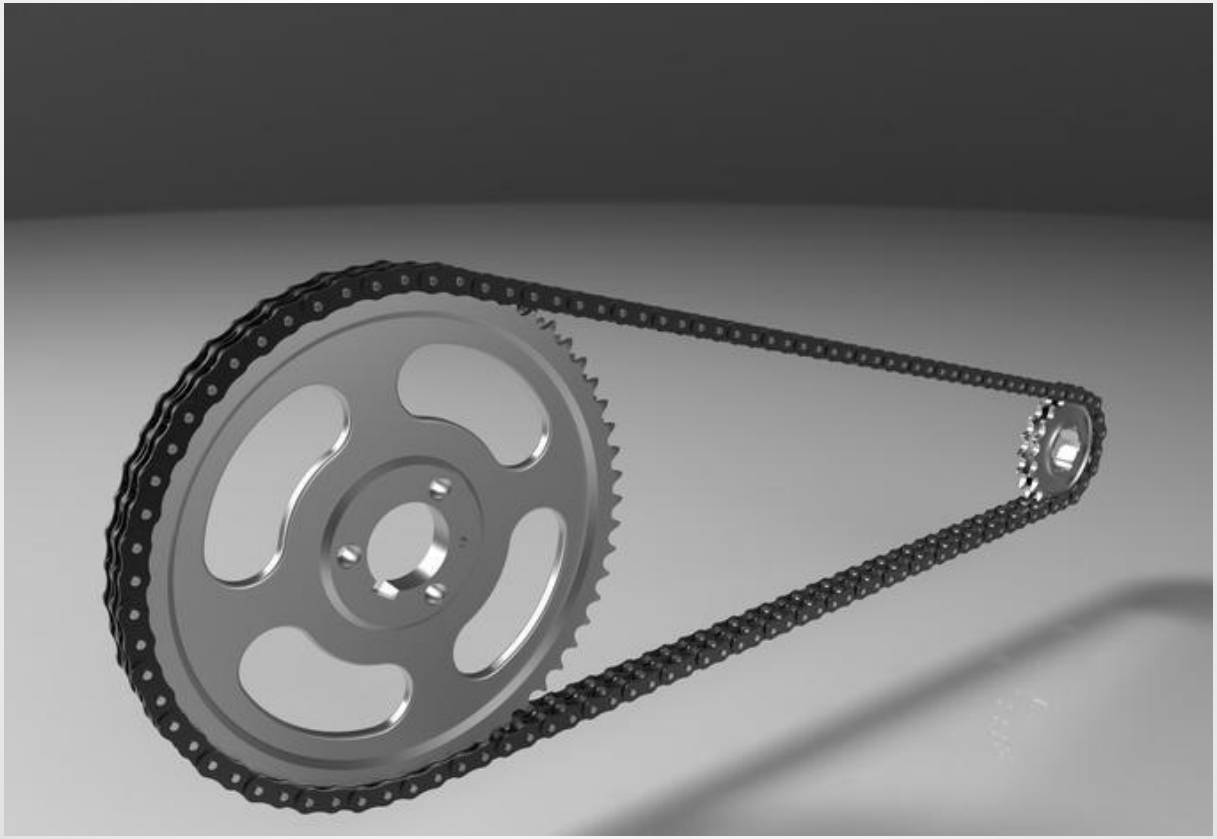
Drivetrain Selection

Roller Chain & Sprocket Drivetrain:

- Low weight
- High simplicity
- Reliable

Drivetrain Selection

Roller Chain & Sprocket Drivetrain:



https://grabcad.com/library/roller-chain-drive-iso-606-05b-2

Drivetrain Decision Matrix

	Low Weight	High Reliability	High Simplicity	Low Cost	Total
Relative Weight	30%	30%	10%	30%	100%
Shaft & Gearbox	1	5	2	3	**2.9/5**
CVT Belt	4	3	3	3	**3.3/5**
Roller Chain & Sprocket	5	3	5	5	**4.4/5**

The highest number we got from this decision matrix was for the roller chain & sprocket drivetrain (4.4 out of 5)

Engine Selection

Honda engines were looked at since they offer the best powerband for small engines

3 Engine's Considered:

- GY6-QMB 50cc
- GX25 25cc
- GX35 35cc

Engine Selection

- Engines are compared by
  - Power Output (5%)
  - Compression Ratio (25%)
  - Aftermarket Support (20%)
  - Starter Type (10%)
  - Clutch Type (10%)
  - Fuel Consumption (10%)
  - Cost (20%)

Engine Selection

Honda GY6-QMB 50cc

(image from www.mbe-motorsports.com)

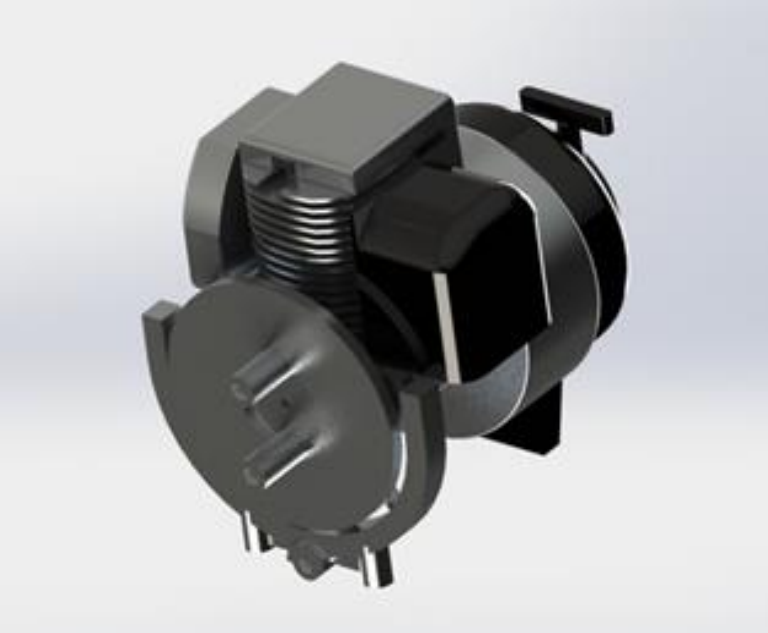
Engine Selection

Honda GY6-QMB 50cc

- High Compression
- Integrated Clutch
- Electric Start
- Strong Aftermarket Support

Engine Selection

Honda GX25



(image from http://grabcad.com/library/honda-g25-2kg-and-300-g-1)

Engine Selection

Honda GX25

- Best use of power
- High fuel efficiency

Engine Selection

Honda GX35

(image taken from http://grabcad.com/library/honda-gx-35-1)

Engine Selection

Honda GX35

- Lowest Cost

Engine Selection Decision Matrix

	Weighted Percentage	Honda GY6-QMB	Honda GX25 25cc	Honda GX35 35cc
Power Output	5%	1	10	5
Compression Ratio	25%	10	1	1
Aftermarket Support	20%	10	1	1
Starter Type	10%	10	1	1
Clutch Type	10%	10	1	1
Initial Fuel Consumption	10%	1	10	5
Cost	20%	1	5	10
Total	100%	**6.85**	**3.15**	**3.4**

Engine Selection Decision Matrix

The Honda GY6-QMB was selected because of its highest potential for fuel efficiency

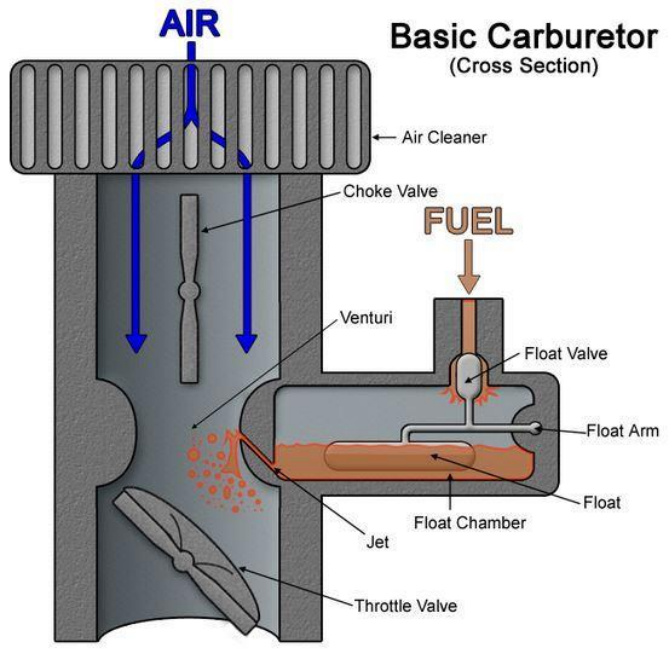
Fuel System Concepts

The team came up with three different concepts related to the fuel system:

- Carburetor
- Fuel Injection
- Forced Induction

Fuel System Concepts

Carburetor



(Image from http://en.wikipedia.org/wiki/User:WikipedianProlific/Gallery)

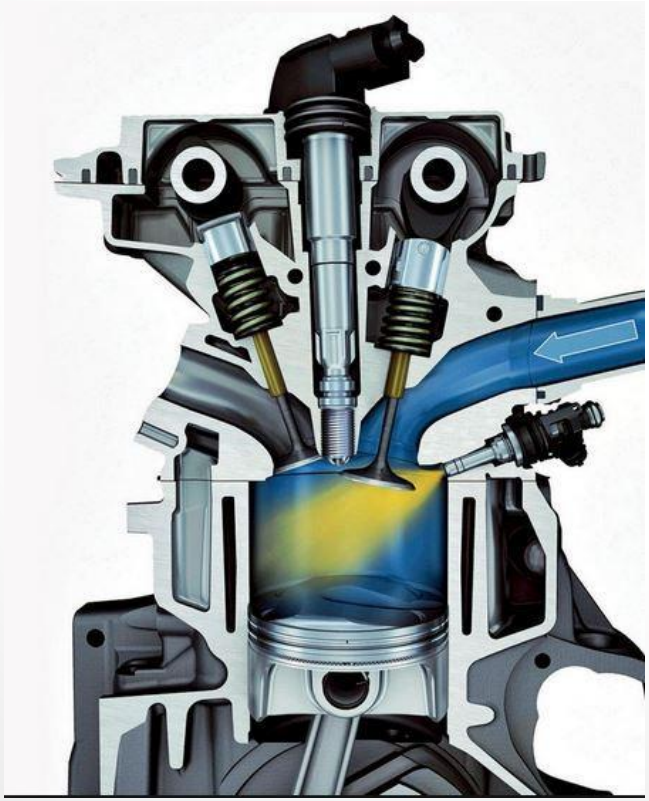
Fuel System Concepts

Carburetor

- Advantages
  - Simple mechanical design (no electronics)
  - Already in-place as fuel system on engine
- Disadvantages
  - Cannot tune very precise
  - Lower fuel efficiency
  - Higher maintenance

Fuel System Concepts

Fuel Injection



(Image from http://www.tgkauto.com/services)

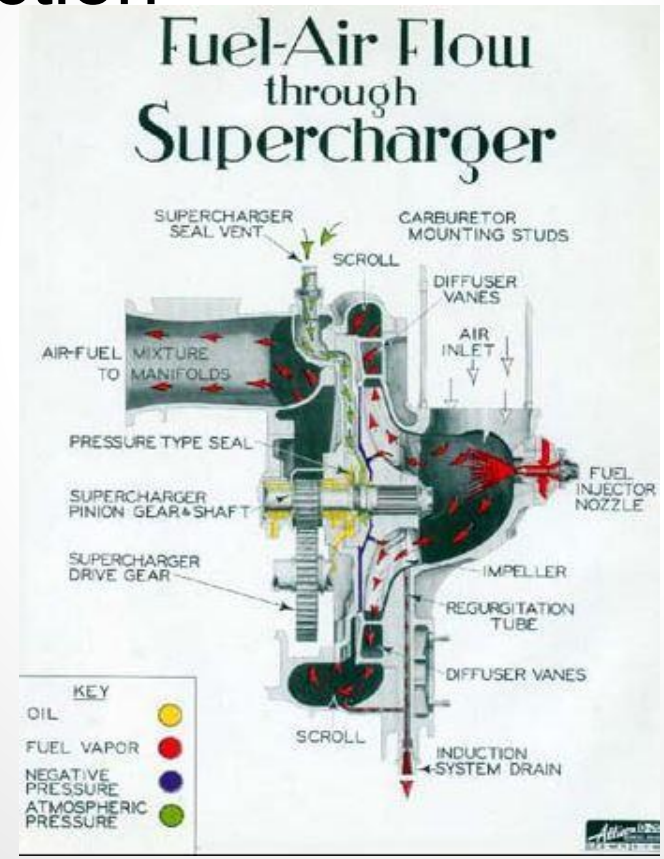
Fuel System Concepts

Fuel Injection

- Advantages
  - Higher fuel efficiency
  - Very low maintenance
  - Very precise tuning (electronics & software)
- Disadvantages
  - Long install time
  - Costs to purchase

Fuel System Concepts

Forced Induction



(Image from http://rwebs.net/dispatch/output.asp?ArticleID=19)

Fuel System Concepts

Forced Induction

- Advantages
  - Increases fuel efficiency
  - Increases compression ratio
  - Precise tuning (electronics & software)
- Disadvantages
  - Very long install time
  - Costs to purchase
  - Very long tuning time
  - Increased maintenance
  - Increased weight

Fuel System Decision Matrix

	Weighted Percentage	Carburetor	Fuel Injection	Forced Induction
Fuel Efficiency (%)	40%	10	50	100
Ease of Implementation (mins)	10%	100	50	10
Precise Tuning	20%	10	100	50
Reliability (days)	15%	10	100	50
Maintenance (mins)	10%	50	100	10
Cost ($)	10%	100	50	10
Total	100%	**27.5**	**72.5**	**60**

Fuel System Chosen Concept

After completing the decision matrix, it was clear to the team that the best fuel system for the vehicle was the fuel injection system. The reason behind this is that the fuel injection system is the most fuel efficient, has the best tuning precision, best reliability, and requires the least amount of maintenance.

Electrical System Concepts

The electrical system will be split up into two sub systems. The first sub system will focus on starting the vehicle up and running the vehicle. This system will include all of the required kill switches, safety fuses, relays, wiring to the electric starter, and various other components related to the specific chosen engine and fuel injection system.

Electrical System Concepts

The second sub system will focus on all of the other accessory components such as the horn, speedometer, GPS system, and possible interior lighting for door handle location. The main power source for the electrical system will be generated from a 12V battery.

Electrical System Concepts

Since the only difference in concept designs is the battery source, the team chose three different batteries for the vehicle:

- Duralast CB Series Motorcycle Battery
- Duralast Lawn & Garden
- Optima Yellow Top

Electrical System Decision Matrix

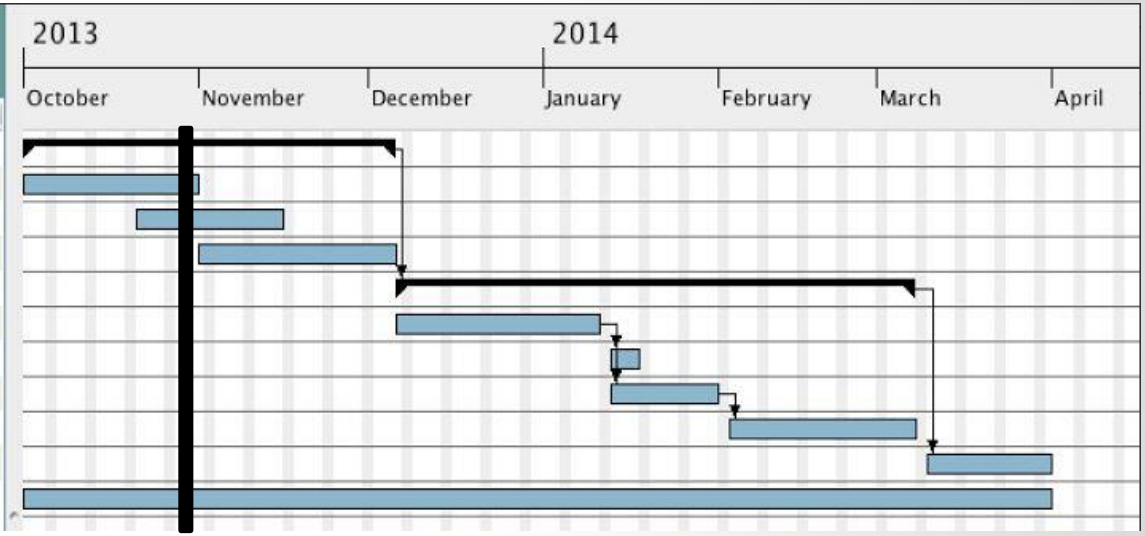
	Weighted Percentage	Duralast CB Series	Duralast Lawn & Garden	Optima Yellow Top
Weight (N)	20%	20	10	2
Scale (cm^3)	15%	15	7.5	1.5
Capacity (Ahr)	40%	20	4	40
Cost ($)	25%	12.5	25	2.5
Total	100%	**67.5**	**46.5**	**46**

Electrical System Chosen Concept

After completing the decision matrix, it was clear to the team that the best battery for the vehicle was the Duralast CB series. The reason behind this is that the Duralast CB series is the lightest, the smallest and still has good capacity and isn’t too expensive.

Project Gantt

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



Conclusion

- Braking system selected uses disc brakes for superior stopping power and high reliability
- Drivetrain selected is chain drive for its low weight, low cost, and high reliability
- Engine selected is the Honda GY6-QMB for best potential for fuel efficiency
- Fuel system selected is fuel injection for the best compromise between efficiency and reliability
- Electrical system uses a Duralast CB Series battery for least weight and cost while still having enough power

Questions?

References

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