Human Powered Vehicle Challenge

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Team 9

Problem Formulation and Project Plan

Document

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Introduction

Team 9 was given the opportunity to build and compete in the Human Powered Vehicle Challenge (HPVC) sponsored by the American Society of Mechanical Engineers (ASME). The HPVC consists of creating a human powered vehicle that can be used as an alternative form of transportation in everyday life. During the competition, the team will be competing in multiple events that evaluate the design, innovation, endurance, and speed of the vehicle. In the design section, the team will be required to write a report that describes the engineering analysis and work that went into the design of the overall vehicle. This paper will discuss a multitude of topics including a need statement, a project goal, objectives and constraints, a Quality Function Deployment (QFD), and a Gantt chart.

Need Statement

After the HPVC was assigned, the group met with the client, Perry Wood, and discussed what outcome he would like to see from this project. After the meeting, the team thoroughly reviewed the HPVC rules set forth by ASME. Multiple topics were deemed important, from which, the following need statement was formed:

"There is no current form of transportation that provides the benefits of bicycle commuting, while offering the practicality of automobiles."

The need statement exposes a noticeable gap between the two categories of bicycle commuting and automobile transportation. For instance, bicycle commuting includes less financial expenditures and traffic, ease of access to parking, and health benefits. Automobiles offer multiple benefits including weather protection, aerodynamics, operator comfort, safety, and cargo space.

Project Goal

From the need statement above, Team 9 created the following project goal:

"Design a human powered vehicle that can function as an alternative form of transportation."

With this project goal the team will have the ability to venture into territories that previous NAU teams have not in the past.

Design Objectives

The design objectives for this project are based on the customer needs, as well as the desire for a successful performance at the ASME Human Powered Vehicle Challenge. The design objectives include the following:

- Vehicle can reach high speeds
- Light weight
- Highly maneuverable
- Contains cargo space
- Large field of view
- Support cargo weight
- Protects rider in the event of a roll over
- Aerodynamic
- Production run manufacturability
- Fits diverse range of operators

Design Constraints

Design constraints were established from the above objectives; these are displayed in Table 1. Additional constraints were taken from the HPVC rulebook [1], to make the vehicle suitable for competition.

Table 1- Constraints

Costumer Constraints	ASME Competition Constraints
Capable of exceeding 40 M/h (64.4 km/h)	Turning radius of ≤ 26.25 ft (8 m)
Vehicle weight of ≤ 80 lbf (36.3 kg)	Capable of completing 6.21 miles (10 km) in under 2.5 hours
Coefficient of drag less than that of a traditional cyclist	Roll protection system must handle 600lbf (2670N) at an angle of 12 degrees from vertical with less than 2 in (5.1 cm) deflection and 300 lbf (1330 N) side load with less than 1.5 in (3.8 cm) deflection
Development budget of $6500.00	Must have a seat belt
	Field of view must equal or exceed 180°
	Vehicle must be capable of traversing a 5% uphill or 7% downhill
	Carry a parcel of 15 X 13 X 7.9 in (38 X 33 X 20 cm) with a mass of 12.1lbf (5.5 kg)
	Come to a stop at a speed of 15.5 M/h (25 km/h) in a distance ≤ 19.7ft (6 m)
	Head lights, tail lights, side view mirrors, reflectors, and a horn

Project Structure

The design of the human powered vehicle will be done collectively among team members. However, each member will have an area of specialty for which they are responsible. A secondary member will aid each of the section leaders in their design work. This team structure allows each subsection to work closely with other codependent sections. The group will be organized in such a manner that no two members will be one another's secondary design support. See Figure 1 for a detailed breakdown of the design team organization.

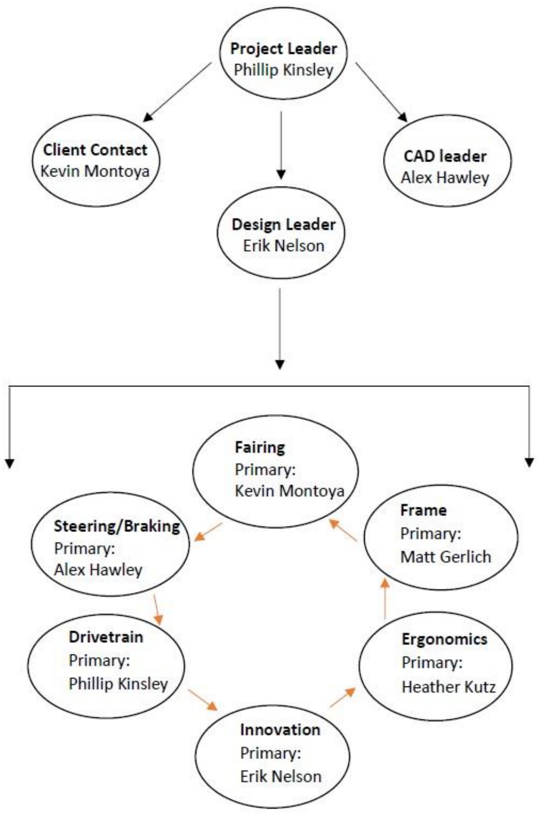

Figure 1- Project Structure

Gantt Chart

A project schedule was generated using Gantt Project software. This will serve as a guide for the team as it progresses through the project. Abiding by this Gantt chart will prevent the team from falling behind. More importantly, the Gantt chart was specifically designed to eliminate wasteful bottlenecks during the design phase. For example, the position of the vehicle operator must be determined before a frame can be built around that rider location. Furthermore, any aerodynamic device that encloses the vehicle and rider is dependent on the frame and rider orientation. These time dependent relationships have been addressed during the creation of the project guide. The project schedule can be seen in Figure 2. The project subsections are color coordinated.

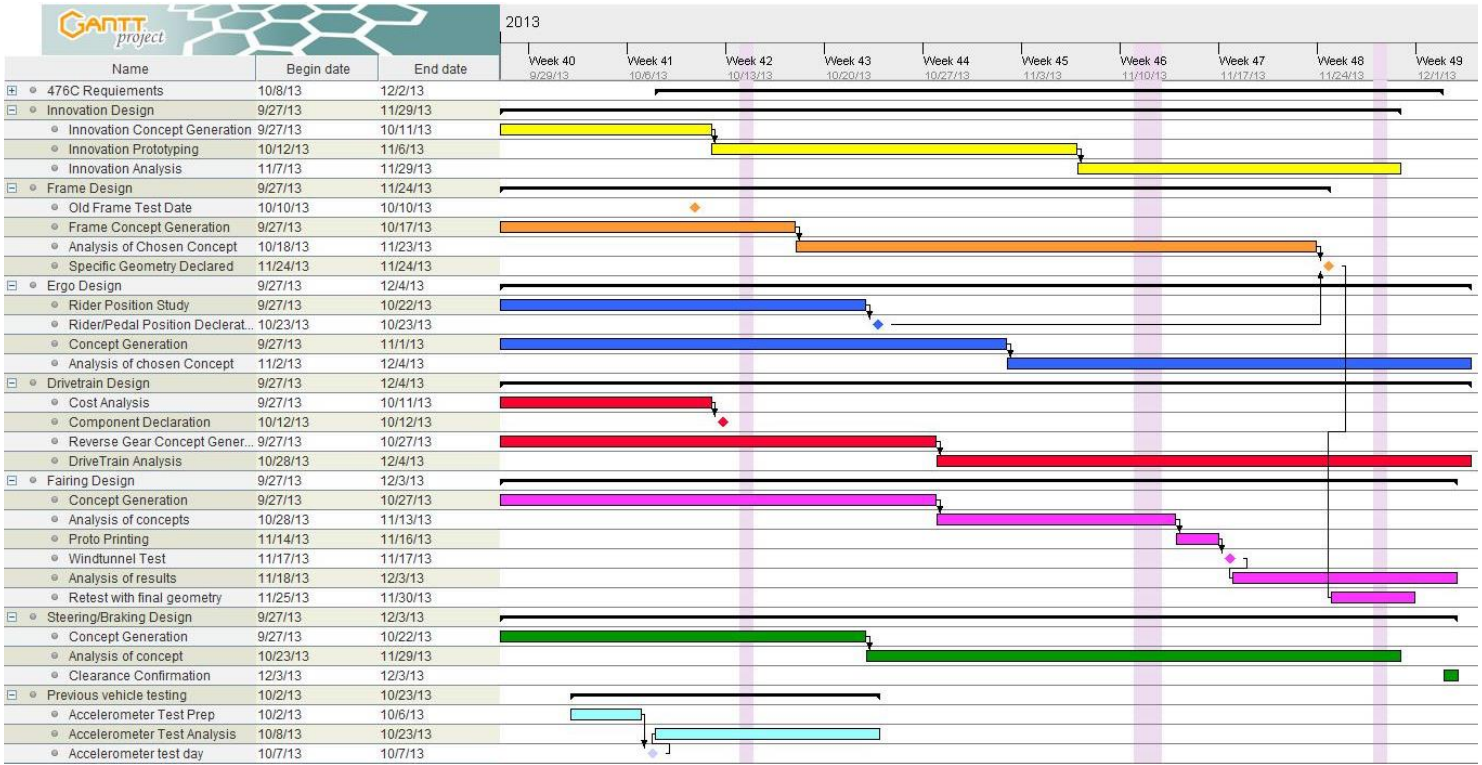

Figure 2- Gantt Chart

Quality Function Deployment

In order for the team to measure the vehicle's features with engineering standards, a QFD was created. The QFD will guide the team in making difficult design decisions with consideration to competitive products. As seen in Table 2, the relationship between engineering requirements, customer requirements, and bench marks from past vehicles will be used to make design decisions. The customer requirements listed are those deemed most important by the client.

Table 2-QFD

		Engineering Requirements									Bench Marks	
		Yield Strength	Deformation	Cost	Velocity	Coefficient of Drag, Cd·A	Volume	Degree	Distance	Weight	The AXE (2012-2013)	Rose Hulman
Customer Requirements	Reach high speeds				x						x	x
	Light weight			x						x		x
	Maneuverable								x	x	x	
	Carry cargo						x			x	x	x
	Large field of view							x				
	Protect rider	x	x									x
	Aerodynamic				x	x					x	x
	Manufacturability			x								x
	Range of rider sizes						x			x	x	
	Units	psi (kpa)	in (m)	$	ft/s (m/s)	in^2 (m^2)	in^3 (m^3)	°	ft (m)	lbf (kg)		
		Engineering Targets										

Conclusion

The vehicle to be designed will provide the practicality of an automobile, while having the benefits of a bicycle. The client for the project is instructor Perry Wood of Northern Arizona University. Through the use of a Gantt chart and a QFD, the team will make design decisions that best reflect the objectives and constraints set by the client and the competition.

References

[1] American Society of Mechanical Engineers, *Rules for the 2014 Human Powered Vehicle Challenge* (2014) [Online]. Available: https://community.asme.org/hpvc/m/default.aspx