ASME
Human Powered Vehicle

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Problem Definition and Project Plan
Document

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Contents

Introduction

The American Society of Mechanical Engineers (ASME) enables collaboration, knowledge sharing, career enrichment, and skills development across all engineering disciplines toward a goal of helping the global engineering community develop solutions to benefit lives. Northern Arizona University (NAU) ASME's primary focus points are projects run by the students, speakers and tours that help the students network with industry professionals, and hosting career development seminars such as the Student Professional Development Conference (SPDC) and career workshops.

Need Statement

Human powered vehicles are heavily used in underdeveloped countries, but they lack in efficiency, reliability, and safety.

Project Goal

The goal of this project is to eliminate vehicles by designing and building safe, efficient, and reliable vehicles that can be powered by humans. Eliminating cars can help the environment as it would decrease pollution. Another purpose is that people in underdeveloped countries would have a safer method of transportation.

Objectives and Constraints

The objective of the Human Powered Vehicle (HPV) is based on what the vehicle is to achieve. First, the vehicle will be made out of lightweight material to reduce the overall weight. Having a light weight material for the frame will help attain speeds of over 30 mph and increase the maneuverability. Using lighter materials will require less power to reach such speeds and reduces the risk of vehicle turnovers; this is important pertaining to the safety of the driver. The frame must also be able to carry additional weight from items that are being transported.

From the design criteria on the HPV competition website, any vehicle entered cannot be the exact vehicle from any of the previous years; it must be newly designed. In addition the vehicle must be able to fit every member of the team inside, individually, and the driver must have a field of vision of 180 degrees. Having 180 degrees of vision helps insure the safety of the driver. In addition to safety, the vehicle must have some form of turning signals, located on the back and front ends of the vehicle, brakes, and a seatbelt for the driver.

Quality Function Deployment

The quality function deployment (QFD) is a tool that aids in relating customer needs to engineering requirements. 10 customer needs were developed as per the ASME HPV website and rules. Following these customer needs, 10 additional design requirements were also developed. By use of a QFD, all 20 of these criteria were related to each other. A detailed quality function deployment displaying this information is located in appendix A. The QFD displayed the most important design requirements by relating them to each of the customer needs. It can be seen that safety in particular will be the most important design requirement to consider due to the fact that it is associated with four of the customer needs. Other notable design requirements include durability and maneuverability which each relate to three of the customer needs.

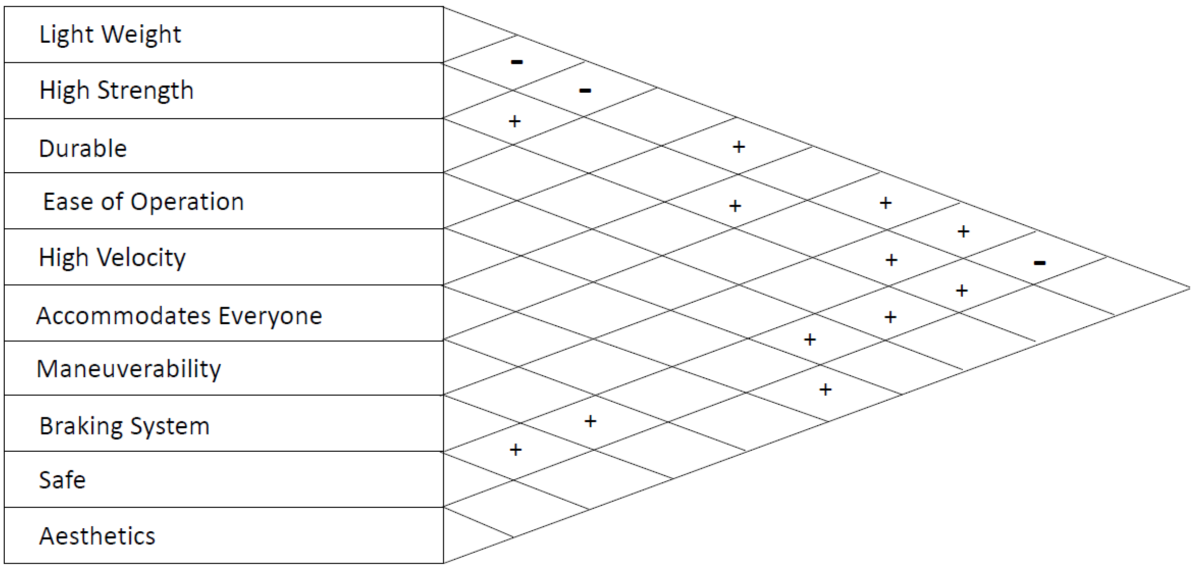
Table 1: Quality Function Deployment

Customer Needs	**Engineering Requirements**	Lightweight	High Strength	Durable	Ease of Operation	High Velocity	Accommodating to All Persons	Manuverability	Braking System	Safe	Aesthetics
Solely Human Powered					x		x				
Travel at Least 10km				x				x			
Has a Rollover Protection System		x	x	x						x	
Comes to a Stop Within 6m While travelling 25km/h						x			x		
Turns Within an 8m Radius								x			
Travels Straight for at least 30m								x			
Utilizes a Safety Harness										x	
Contains no Hazardous or Sharp Edges										x	
Sustains Forces of 2670N and 1330N to the Top and Side of Vehicle, Respectively			x	x						x	
Accommodates Any and All Team Members							x				
Aesthetically Pleasing											x

House of Quality

The house of quality is similar to the QFD in that it relates design requirements to themselves as compared to the customer needs as the QFD does. A house of quality was produced and can be seen in appendix B. Notably, the house of quality shows that safety is again related to five other design requirements. High strength and light weight also had a positive correlation, as well as high velocity and light weight.

Table 2: House of Quality



Project Plan

The project plan (Appendix) is broken down into four sections delineated by presentation due dates. In the product specification and project planning section the groundwork is laid for the rest of the project: the problem definition is established, the client's needs are assessed, and the objectives and constraints of the project are set in place. While this portion is the most critical to the success of the project, it takes the least time.

Most of the actual design work is done in the second section of the project: concept generation and selection. Four weeks are taken to generate concepts, evaluate them relative to the objectives and constraints, and iterate until a satisfactory conclusion is reached. Each individual step overlaps another as evaluation and refinement of concepts occurs more or less simultaneously. Also overlapping each of those steps is the beginning of the third section of the project, the analysis portion. Six weeks is allotted for the creation of models, either physical or computerized. After the initial simulations are usable there is time budgeted for a preliminary analysis. At that point the team will meet to determine which objectives and requirements are the most important to the success of the project, and decide which will take priority. After further refinement of the design, the team will conduct a design review as a way to apply common sense and practical knowledge and check for overlooked errors. Another design review will be conducted in the last section of the project, after each individual component has been integrated into a single, comprehensive computer model. After this final review, the project proposal will be assembled and presented.

State Of The Art Research

Human powered vehicles have been around for years, mainly due to modern society’s desire to reduce the consumption of fossil fuels. Most designs are similar to and share many components with bicycles, with which most everyone is familiar. But recently there have been a lot of innovations in the world of human powered vehicles. One example is the material in which they are constructed of, such as alloys and composites to reduce weight yet maintain the structural integrity of the vehicle. There is also an increase in the number of designs using a dual drive action, which means both the rider's legs and arms transmit power to the drive wheel. The idea behind this is to increase the amount of power a person can provide the vehicle in turn making it more efficient. Most vehicles have the rider in a recumbent (lying down) position to help reduce the front cross-sectional area and increase the aerodynamics of the vehicle.

Conclusions

ASME has organized the Human-Powered Vehicle competition to encourage creative thinking about the issue of transportation in developing countries. Many people in underdeveloped countries cannot afford safe, reliable vehicles, so the goal of this project is to provide such a vehicle at a low cost by using only human power as a motive force. In order to provide the best solution to the problem, the weight, speed, safety, cost, and size of the vehicle will be considered most carefully and optimized in relation to each other. The following constraints apply to the vehicle: it must be an entirely new design, powered solely by human input, it must be able to fit every member of the team inside, individually, the driver must have a field of vision of 180 degrees, the vehicle must have some form of turning signals on the back and front ends of the vehicle along with brakes and a seatbelt for the driver.

The quality function deployment demonstrates that safety is the most important design requirement, a conclusion reinforced by the house of quality. This will give guidance throughout the design process. The project plan sets forth a guideline for what needs to be done to finish the design and when each step ought to be completed. Research done into the current state of the HPV art reveals that the industry is on the cusp of several performance breakthroughs that could revolutionize these vehicles as an effective mode of transportation.

References

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"The Recumbent Bicycle and Human Powered Vehicle Information Center." The Recumbent Bicycle and Human Powered Vehicle Information Center. N.p., n.d. Web. 23 Sept. 2015.

Appendix

Table 3: Project Plan

	Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
Product Specification and Project Plan	Meet with client	■												
	Problem definition	■												
	SOTA research	■	■	■	■	■								
	Establish objectives/constraints/requirements	■												
Concept Generation and Selection	Concept generation		■											
	Rudimental concept evaluation		■	■										
	Refinement of select concepts			■	■									
	Concept evaluation				■	■								
	Concept selection					■								
Engineering Analysis	Concept simulation		■	■	■	■	■	■						
	Initial analysis/simulated testing						■	■	■					
	Objective prioritization								■	■				
	Design/model refinement								■	■				
	Design review									■				
Project Proposal	Model synthesis										■			
	Design review											■	■	
	Presentation/report finalization												■	■