Needs Assessment Report

Team 3

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Date Submitted: 9/30/16

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ABSTRACT

Racing has always been the pinnacle of available technology. It gives people the ability to push our limitations with new materials and technologies that eventually trickle their way down into our daily lives. Our task is to devise a faster way for top fuel drag racing engines to level the intake manifold and bolt down properly. It must be a simple, cheap, reusable, fast, and durable piece of equipment to decrease the amount of time it takes the team to rebuild the engine. This could lead to tools used in every mechanic shop ensuring parts are properly mounted to prevent gasket failures, increase the life of motors, and decrease repair time.

1. Introduction

1.1 Project overview

Cummins works with the NHRA in Top Fuel Nitromethane engine development. After every 1000 foot race, the engine must be rebuilt. The engine is generally rebuilt over a 20 minute period. Traditionally, in order to align the supercharger with the intake manifold, a dial gauge is used on each bolt to ensure precision. This process takes a lot of time, but if a new digital tool is created this time can be significantly reduced.

1.2 Research/Future Information

As a team, we must design a tool that is able to assist the crew with aligning the supercharger to the intake manifold. In order to do this we must follow our sponsor's constraints and requirements. In the near future, we will receive an engine from our sponsor which will allow us to begin a prototype of our design. We intend to use sensors such as accelerometers and gyroscopes to give us digital values. After we have the dimensions of our sensors and boards, we can create a prototype of our design using AutoCAD.

1.3 Constraints

The constraints given to our team by Cummins are that the power supply for the device has to be internal. Cummins does not want to have to plug in the device to an external outlet in order to run the device on top of the engine. [1]

Cummins requires the device to read values in under one second and it has to be accurate within ± 0.005 in. Cummins also requires a fast calibration and startup of the device so that time is saved rebuilding the engine, along with a method for quick repeatable placement.

The size of the device needs to be portable and compact so that it can fit in a tool box at the race site. The casing for the device that holds the computer module needs to be durable and withstand drops. The readout from the computer needs to be able to be read from each side of the engine, since there are mechanics working on each side of the engine.

1.4 Goals/objective

Our overall goal as a team is to create a tool to aid in aligning the supercharger to the intake manifold on a TOP Fuel nitromethane drag racing engine. This should help shorten the time it takes to rebuild the motor in between races. It should be easy and quick to use, and much faster than the methods that are currently used.

2. Background and Literature Review

Our project involves working with a drag racing engine. Our areas of concern in the engine are the engine block, intake manifold, supercharger, and the air intake sitting on top of the entire assembly. In order to fully understand the project scope, we must understand each individual component in the assembly, which are discussed in the following paragraphs. Aside from the engine components, we will be testing different methods of determining just how far off the supercharger is sitting from the plane of the intake manifold. We will most likely use an accelerometer for this purpose, which is also discussed below.

A supercharger on a car is an air compression device. This compressed air allows the engine to burn more fuel in the cylinder, and hence deliver more power to the crankshaft. Drag race cars are famous for their high performance and speeds, so a supercharger is necessary for the car to meet the required performance standards. Below the supercharger is the intake manifold. This is responsible for actually supplying the compressed air from the supercharger into the piston cylinders. It is important that this manifold provides an even and smooth distribution to the cylinders, or else the combustion will not be clean and uniform. There are many undesirable effects of this sort of unclean combustion, including extra forces that decrease the efficiency of the engine. These forces can also add extra stress that can cause connections to fail or start to separate.

Our project is concerned with maintaining a level platform between the supercharger and the intake manifold. These two can become slightly separated at the connection screws due to the amount of vibration the typical drag car engine receives. To put the drag racer into perspective, most cars produce about 100-200 horsepower. Our drag car produces 10,000 horsepower. At such a high power, there are extremely high vibrational forces on the engine parts. Due to these high forces, certain drag race components must be replaced after every race. When putting the engine back together it is crucial for the engine block, intake manifold, supercharger, and top air intake to be aligned with each other. If not, the engine may suffer excess wear or failure. For this purpose, a dial gauge level is used to give feedback to the mechanic so that the engine can be assembled properly. A better option is a digital level because of its ability to quickly give feedback.

Digital levels use an accelerometer, which is a sensor that measures changes in acceleration. Accelerometers are also present in smartphones and digital compasses. In general, they provide feedback that lets a device know what its orientation is in respect to a level platform. It can do this in two different ways. The capacitance accelerometer senses changes of capacitance between microstructures which are next to the device. If there is a change in acceleration, it will move one of these structures. This will change the capacitance, and the accelerometer will translate it into an output voltage for interpretation. While the capacitance sensor is useful, the piezoelectric accelerometer is actually the most common type. The piezoelectric accelerometer uses microscopic crystal structures which become stressed when put under accelerative forces. These stressed structures generate a voltage which can be interpreted to determine velocity and acceleration.

3. Methodology

The first stage is to analyze the problem. It is key to physically access and take measurements of the engine components. These dimensions will have a large effect on the amount of precision needed from the tool.

The second stage involves brainstorming solutions. This includes picking out the various components needed to complete the device. Once an array of parts have been compiled we must choose which ones to purchase. This will be done by minimizing the cost while selecting a system of parts that will achieve results at or above the required constraint values.

The third stage is to prototype the device. This involves putting together the components and programming the tool. Fabrication of custom parts will also be done during this stage. The prototype will then be tested and benchmarked.

The fourth stage is translating from the prototype to the final design. Any issues with the prototype will be corrected. This could involve new components or software adjustments.

Table 1: Gantt chart

	Task Name	Duration	Start	End
1	**Senior Design: Semester 1**	**60 days**	**9/13/2016**	**12/5/2016**
2	Code of Conduct	4 days	9/13/2016	9/16/2016
3	Needs Assessment Report	11 days	9/16/2016	9/30/2016
4	Revised Code of Conduct Report	6 days	9/30/2016	10/7/2016
5	Midterm 1 Presentation	6 days	10/1/2016	10/10/2016
6	Midterm 1 Report	13 days	10/5/2016	10/21/2016
7	Initial Web Page Design	15 days	10/10/2016	10/28/2016
8	Peer Evaluations	2 days	10/20/2016	10/21/2016
9	Midterm 2 Presentation	17 days	10/21/2016	11/14/2016
10	Peer Evaluations	2 days	11/17/2016	11/18/2016
11	Final Web Page Design	17 days	10/29/2016	11/22/2016
12	Poster Presentation	14 days	11/14/2016	12/1/2016
13	Final Report	16 days	11/14/2016	12/5/2016

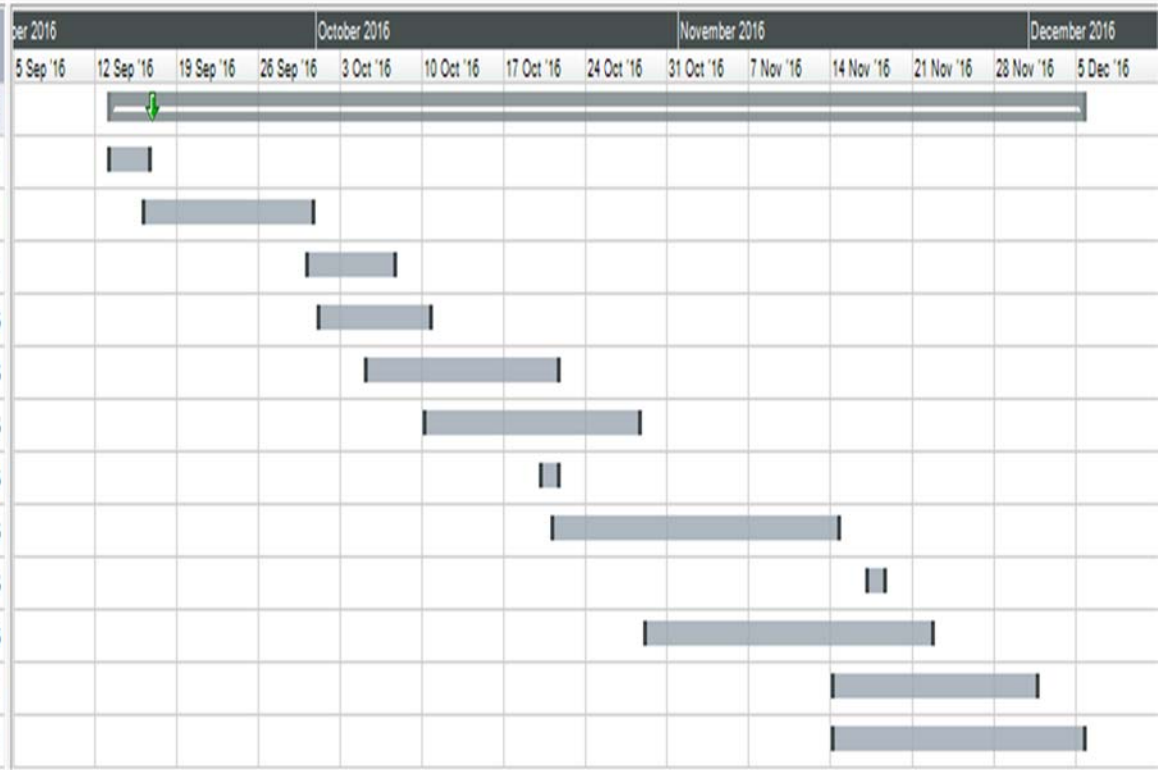

Table 2: House of Quality

Customer Needs	Priority	Technical Specifications: Accurate to +/- 0.005	Processor speed	Independent power sourse	Durable Case	Method for quick repeatable replacement
Price	1	1	1	1	1	1
Portable	5				2	
Stand alone os	5			5		
Calcualtes under 1 second	5		5			
impact resistanct	4				5	
fast startup	4		5			
simple and fast interface	4		3			
Interface seen from both sides of engine	5					
fast calibration	4		3			5
Meets Accuracy needs	4	5				
Score		21	70	26	31	21
Relative Weight		12.4	41.4	15.3	18.3	12.4
Rank		4	1	3	2	4

5. Conclusion

Following our Gantt chart and our technical specifications on the house of quality we will have a product ready for the racing team to use before the end of may. It will meet all of the needs of the racing team and decrease the rebuild time for their motor. This technology could even trickle down into our everyday lives and be used in many engine repair facilities.

References

[1] Hays, Michael, D.Eng. "Project Overview." Telephone interview. 28 Sept. 2016.