Cummins: Water Spray System

Senior Design Group #17

Needs Assessment and Project Scope II

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Group Members:

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Needs Assessment

Cummins currently employs a water spray system at their facilities to conduct endurance tests on their engines. One specific test is meant to simulate water splashing onto the engine, for instance from a truck driving over a puddle. The system currently in use, while it does meet design requirements, is inefficient and not as robust as desired. A schematic drawing of this inefficient system can be seen in Figure 2. Our task is to design a new water spray system that is more efficient, stable, and has increased repeatability over the current system.

Project Scope

Problem Statement:

The emphasis of this project is to design a water spray system comprising of a structurally sound, efficient piping structure and automated controls. The system must be capable of spraying both sides of the engine, assumed to be 6ft in length by 3ft in height and 3ft off the floor, defined in Figure 1, so as to reach all the electrical components of the engine. Essentially, the system must be capable to spraying components located in both directions of the BC plane.

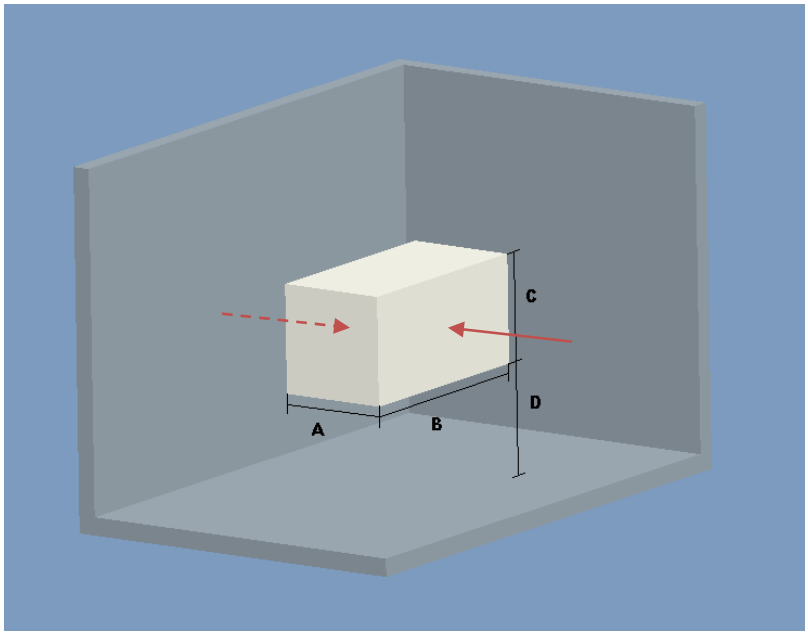


Figure 1 – Defined Spray Area; A = C = D = 3ft, B = 6ft

Justification/Background:

The client of the water spray system for engine testing is Cummins Inc., located out of Columbus, Indiana. Cummins is a leading developer and manufacturer of diesel power systems, both in the United States and globally, serving customers in over 190 countries and territories. Cummins is performing these water intrusion tests to insure that the electrical components are not affected or damaged by water splashing on them, for instance, a truck driving through a puddle of water.

The system operates in a testing facility for engine development where engines can be run for long periods of time on specially designed rigs. Cummins currently utilizes a water spray system designed to test electronic connections on their engines in order to simulate these real-life situations. The current system operates under fully manual controls, i.e. an employee must manually adjust the positions of the water sprayer and activate the water flow over set intervals. The need for human control and interaction results in inefficient testing and use of time. In order to properly test these engines, they must run these tests for long periods of time. This requires a Cummins' employee to be constantly monitoring the system during the testing period in order to turn the spray system on and off at specified intervals. While we realize that we are to develop own our optimized design, we believe it is also important to understand what designs have been implemented previously. A schematic of the existing system employed by Cummins can be seen in the figure below.

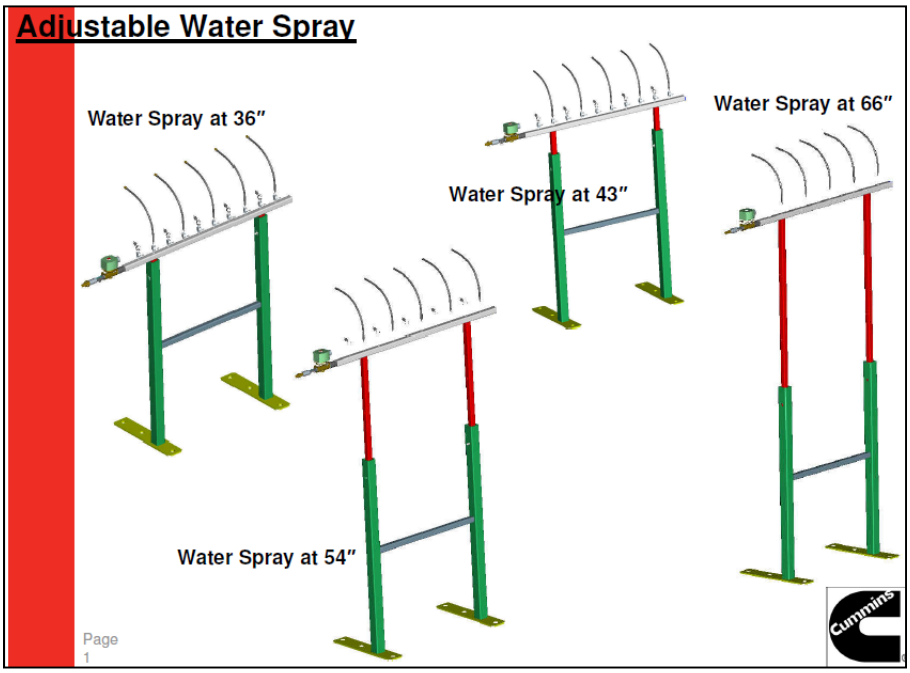


Figure 2 – Current System

Objective:

The chief objective of this project is to design, analyze, prototype, and test a working model of an automated water spray system. The system will be governed by a graphical user interface (GUI), connected to a pump and valves via analog to digital converters. By designing a new system which incorporates automated controls, this will allow the test engineer more freedom and potentially the ability for one person to monitor multiple tests simultaneously, which saves on labor costs. Also, by automating the system, this gives the test greater repeatability and accuracy by removing an aspect of the human-system interface.

The design requirements for this project involve the ability to adjust the settings of the system. These settings will include the flow rate, spray duration, and also the intervals over which the spray testing will occur. The height of the spray nozzle will also be capable of being adjusted via slotted 80/20 aluminum. An important aspect of this design is the ability of the nozzle to spray every location of the engine so as to ensure that the electrical components in question interact with the water. It is also important that the spray coverage area is relatively even to increase the repeatability of the system testing.

Methodology:

Having ordered most of the major components of our system, our first goal is to experimentally set up our system without any automation. By doing this we will be able to determine any changes that need to be made to the system as far as the water delivery system and structures are concerned. The first step to this process is to select the correct nozzle. We have ordered three nozzles that should work and are going to test each individually for flow and spray characteristics before ordering the remaining components. Having selected the appropriate nozzle, the piping system and main structures can be assembled with the pump. With the system assembled and operating within defined parameters, the software can be developed which will govern the system automatically. With the system fully operational, an operator’s manual will be constructed to allow for ease of use by our sponsor.

Expected Results:

We anticipate that the system will be at least marginally operating within design parameters by early March to allow for time to fine tune and test the system enough times so that we can guarantee that our sponsors will get a product which they will be satisfied with. Ideally we would like to have our project completed prior to the end of semester Open House to allow for travel time to the Cummins facility in Indiana so that we can set up and test our system in the environment that it will be operating in.

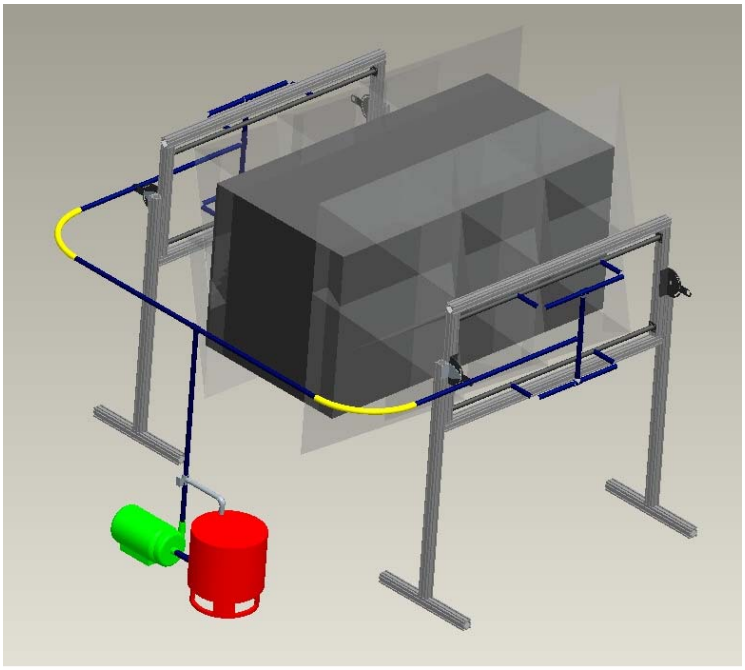


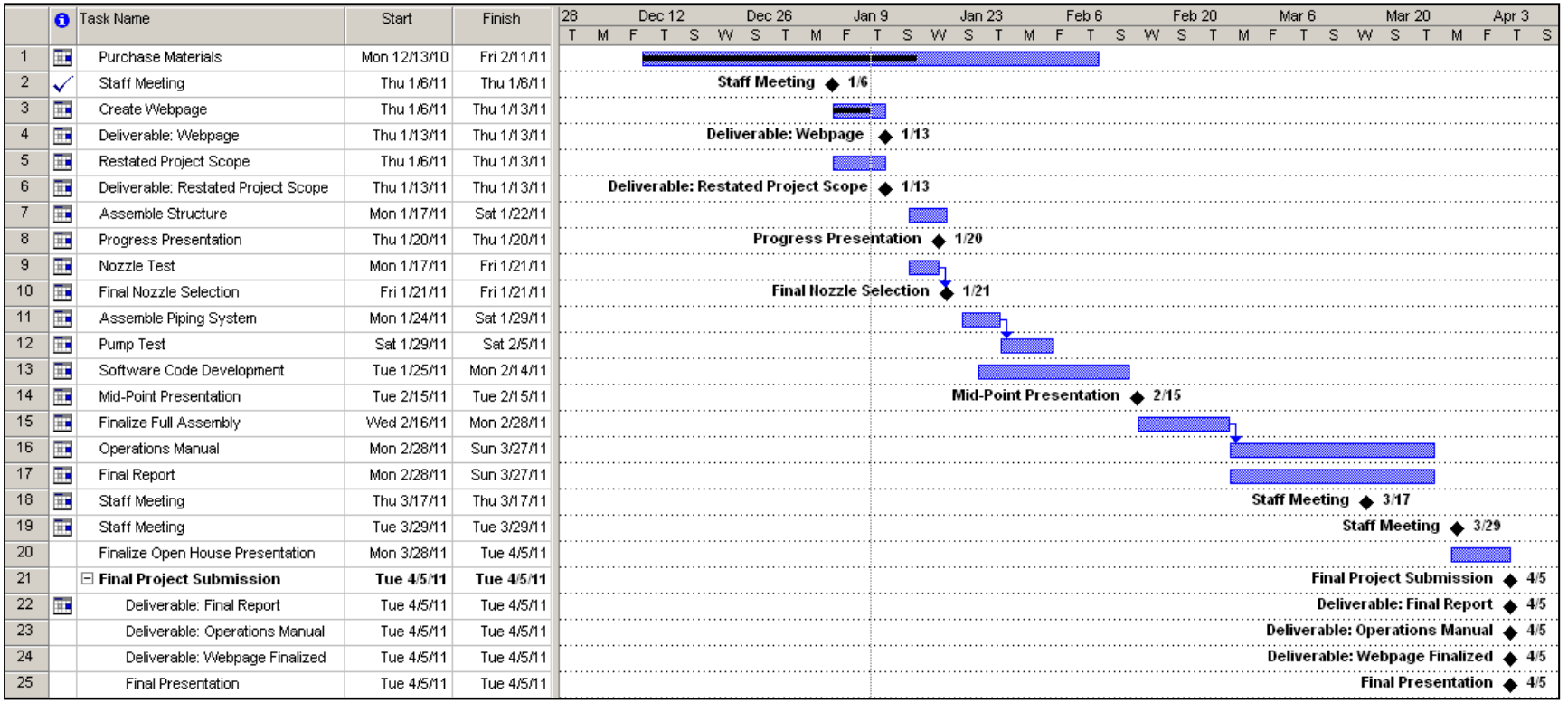
Figure 3 - Updated System

Constraints:

As far as design specifications are concerned, the constraints are limited regarding the design of the system. The settings must be able to be adjusted. The testing facility is already in place; therefore our space constraint is clearly defined and limited. Our working model must be able to be implemented within these space constraints. Our budget is also preset requiring much attention to the financial aspects of the project. The final project must be completed before April of 2011.

Project Plan:

The Gantt chart below shows our project plan for the spring semester. The milestone items represent deliverables to be turned in or scheduled Staff Meetings.



	Task Name	Start	Finish
1	Purchase Materials	Mon 12/13/10	Fri 2/11/11
2	Staff Meeting	Thu 1/6/11	Thu 1/6/11
3	Create Webpage	Thu 1/6/11	Thu 1/13/11
4	Deliverable: Webpage	Thu 1/13/11	Thu 1/13/11
5	Restated Project Scope	Thu 1/6/11	Thu 1/13/11
6	Deliverable: Restated Project Scope	Thu 1/13/11	Thu 1/13/11
7	Assemble Structure	Mon 1/17/11	Sat 1/22/11
8	Progress Presentation	Thu 1/20/11	Thu 1/20/11
9	Nozzle Test	Mon 1/17/11	Fri 1/21/11
10	Final Nozzle Selection	Fri 1/21/11	Fri 1/21/11
11	Assemble Piping System	Mon 1/24/11	Sat 1/29/11
12	Pump Test	Sat 1/29/11	Sat 2/5/11
13	Software Code Development	Tue 1/25/11	Mon 2/14/11
14	Mid-Point Presentation	Tue 2/15/11	Tue 2/15/11
15	Finalize Full Assembly	Wed 2/16/11	Mon 2/28/11
16	Operations Manual	Mon 2/28/11	Sun 3/27/11
17	Final Report	Mon 2/28/11	Sun 3/27/11
18	Staff Meeting	Thu 3/17/11	Thu 3/17/11
19	Staff Meeting	Tue 3/29/11	Tue 3/29/11
20	Finalize Open House Presentation	Mon 3/28/11	Tue 4/5/11
21	**Final Project Submission**	**Tue 4/5/11**	**Tue 4/5/11**
22	Deliverable: Final Report	Tue 4/5/11	Tue 4/5/11
23	Deliverable: Operations Manual	Tue 4/5/11	Tue 4/5/11
24	Deliverable: Webpage Finalized	Tue 4/5/11	Tue 4/5/11
25	Final Presentation	Tue 4/5/11	Tue 4/5/11