Cummins Water Spray System

Concept Generation and Selection

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Date of Submission: 10/14/2010

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Problem Statement

Cummins has a water spray system at their facilities to test engines. The one that they currently have is inefficient and not as robust as they would like. Our job is to design a new water spray system that is automated so that it increases the efficiency of their test.

Objective

The objective of this project is to design and manufacture an automated, efficient water spray system to be used in engine splash testing by Cummins, a diesel engine manufacturer for applications ranging from automotive to industrial construction equipment and power supplies. The design will feature automated motion capable of spraying any portion of the engine being tested, specifically individual electrical components used to monitor and control engine conditions. The motivation behind this project is to reduce the need for human-system interaction resulting in more efficient testing with increased repeatability.

II Concepts Generation

Concept 1

This design institutes a flex hose attached to a stationary base. The base will be two reverse steel t-junctions with a horizontal crossbar for increased stability. The flex hose will be 5 ft long so that it will be able to reach anywhere on the test section. There will be a nozzle attached to the end of the flex hose. The pipe hose will be rubber and run along the inside of the t-junction and flex hose connecting to the valve. It will utilize a pump that will be controlled by a controller so that there is no need for a valve. The design will be replicated on the opposite side and have a different pump. This design will use a hardware interface to input the duration of the spray and the frequency of the spray.

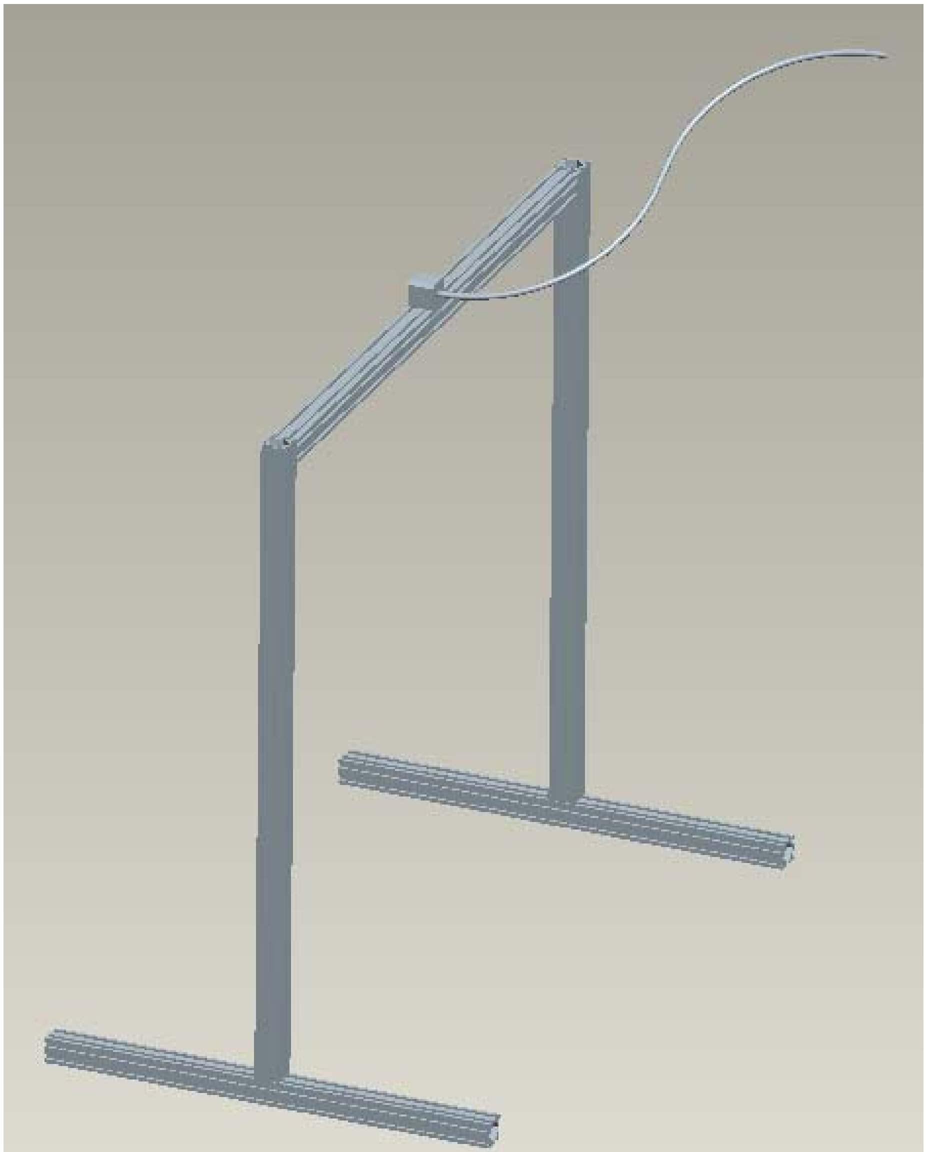

Figure 1: Concept #1

Concept 2

This design uses multiple set screws along tracks powered by multiple motors (X-Y table). This design will implement a rectangular base to not only help support the X-Y table but also to have the X-Y table stand 3 ft off the ground so that it can move through the test section. Another hand cranked set screw will be used to move the platform, which will have the nozzle attached to it, in the 3rd dimension. This design will again be replicated on the other side. It will use a pump for each side of the spray system and about 9 ft of rubber hosing connecting each pump to the nozzle. This design will involve a Graphical User Interface (GUI). This will allow the user to type in a time and frequency of the spray as well as input coordinates and the order in which they will execute the points. The most likely program that will be used is Lab View but other programs are also being considered.

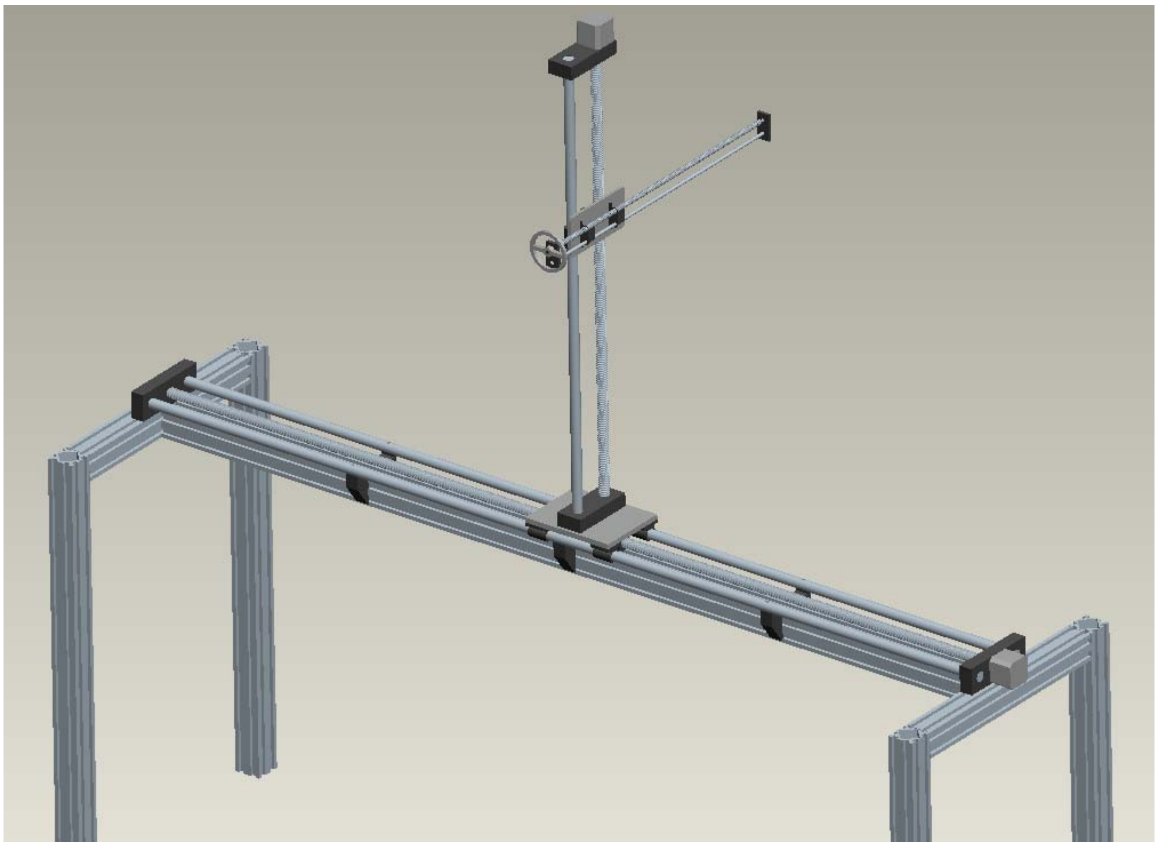

Figure 2: Concept #2

Concept 3

This design will use be identical to the concept 2 however, instead of designing and building an X-Y table it will be purchased from Nook industries.

Figure 3: Concept #3

III Concept Selection

Cost Analysis

Concept 1

Components	Cost (dollars)
Flex Hose	150
Pump	50
Infrastructure	100
Water Hose	40
Controller	50
Analog to Digital Converter	40
Nozzle	25
Total	**455**

Concept 2

Components	Cost (dollars)
Power Screw Components	200
Tracks	100
Bearings	90
Pump	50
Infrastructure	100
Water Hose	40
Motors + Controllers	450
Software	0
Analog to Digital Converter	40
Nozzle	25
Total	**1095**

Concept 3

Components	Cost
X-Y table (Nook industries)	1600
Pump	50
Infrastructure	100
Water Hose	40
Motors + Controllers	450
Nozzle	25
Software	0
Analog to Digital Converter	25
Total	2290

Decision Matrix

		Concept #1 Flex Hose		**Concept #2 2D Automation**		**Concept #3 2D Automation (Nook Industries)**	
Characteristic	**Weight**	**Score**	**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**
Automation	40%	2	0 .8	6	2.4	6	2.4
Cost	30%	8	2.4	5	1.5	0	0
Repeatability	10%	2	0.2	6	0.6	6	0.6
Stability	20%	6	1.2	6	1.2	6	1.2
		Total:	4.6	Total:	5.7	Total:	4.2

Decision Matrix Specifications

	Cost	Automation	Stability	Repeatability
0	2000+	No Automation	Not Stable	Unrepeatable
2	1600-1800	Spray Automated		Low P Low A
4	1200-1400	Spray and 1 axis		
6	800-1000	Spray and 2 axis	Stable	High P Low A
8	400-600	Spray and 3 axis		
10	0-200	Spray and 5 axis	Fully Rigid	High P High A

Each of the weights given was chosen by how the group deemed the importance of each of the design characteristics were from our communications with our sponsor. Automation is by far the most important design characteristic since it is what their current design lacks. Cost was weighted slightly less since it is only considered because of our budget constraint and is this design in not for commercial use. Stability was given a significant weight since Cummins said that the system that is to be developed needs to be able to last and not break down. Since the reason for this system is to do a water spray test then our group felt that it would be good to factor in how repeatable the test would be from our design concepts.

IV Conclusion

With the given problem statement and objective, 3 concepts were developed to satisfy our customers demands. When developing the concepts, the only criteria used was that it satisfied all of the requirements given to us by Cummins. After that, our group determined the 3 most important criteria from our sponsors and came up with a decision matrix with weights determined by the relative importance to Cummins. With this our 2nd concept was deemed to be the best design.

The second concept goes beyond the need that Cummins gave us while staying within the budget. It allows for very efficient operation since there will be minimal human interaction in the testing of the engines and this saves time which in turn saves money. This design is also the most adaptable, should a problem arise when further analysis is done on the concept. It allows for further improvement if it is deemed feasible to do within our time frame depending on the amount of money left in our budget to left after purchasing everything for the design.

V References

Alvi, Dr. Farrukh S. Lab1: “Pipe Flow: Major and Minor Losses”. FAMU/FSU College of Engineering. EML4304: Experiments in Thermal Fluid Sciences, 2010

Janna, William S. *Design of Fluid Thermal Systems.* Stamford, CT: Cengage Learning, 2011. Print.