Water Spray System

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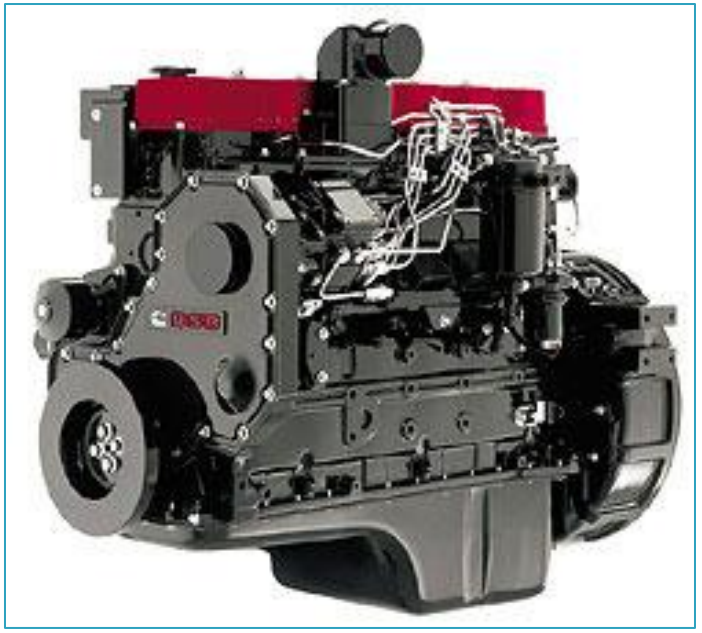
Overview

- Introduction
- Initial Design Concept
- Revised Design Concept
- Piping Structure
- System Interface
- Cost Analysis
- Conclusions
- Future Work



A 215 hp Cummins diesel engine

Project Background

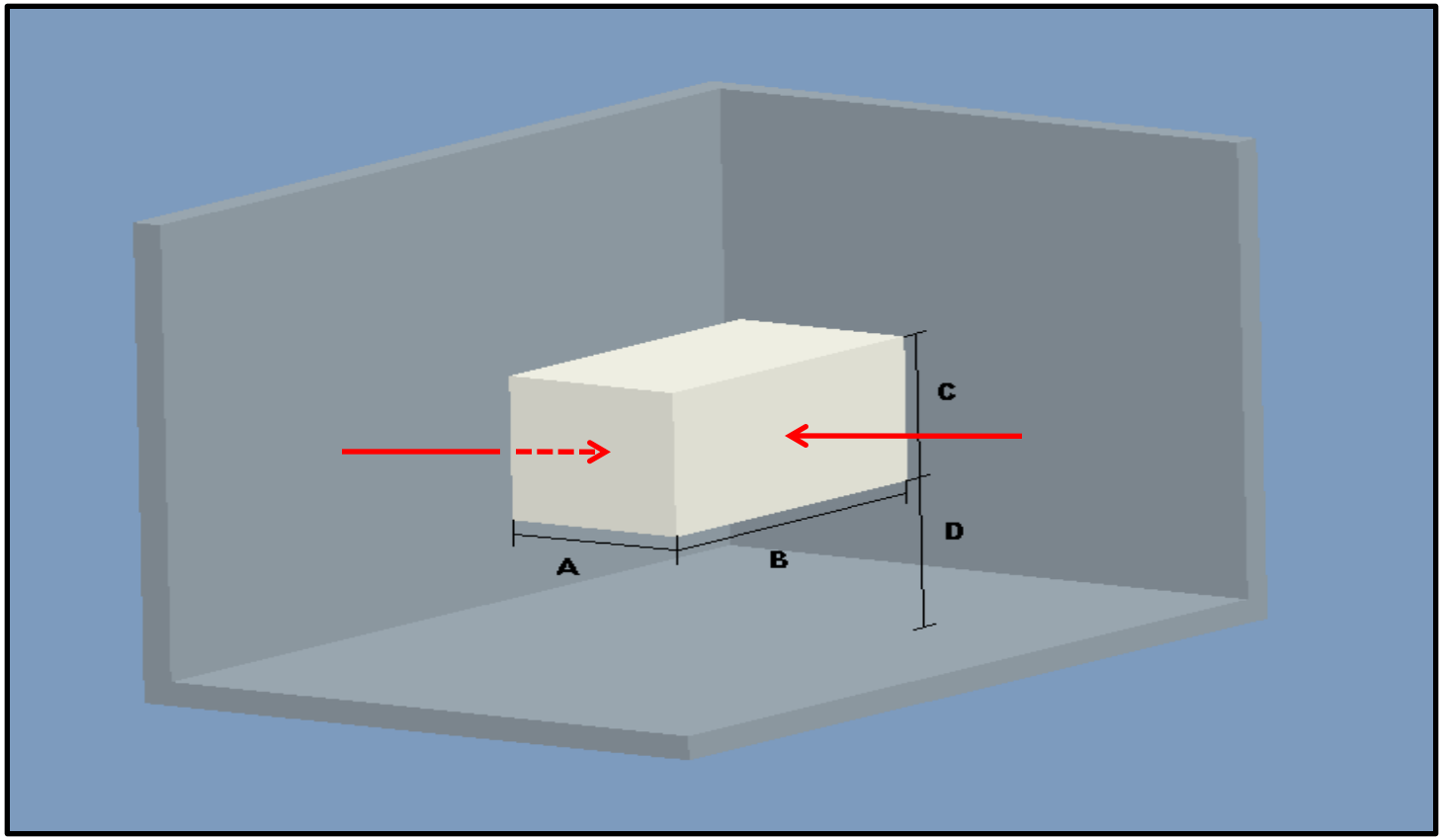
- Cummins tests the effect of water on engines and their electrical components

- The test simulates the effect of driving over water puddles by spraying an engine undergoing an endurance test

Product Specifications

- Capable of spraying 3 ft x 6 ft area
- Stable structure
- Automated/Variable Spray Settings
  - Spray Duration
  - Spray Intervals
- Flow rate of 1 gpm

Product Specifications



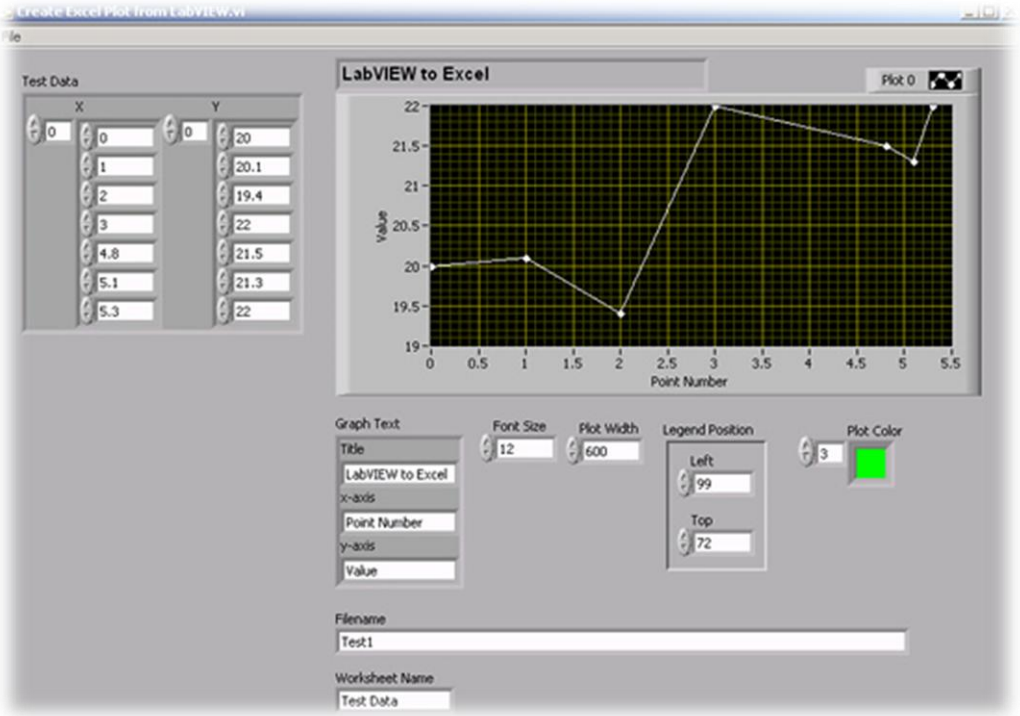
Arrows indicate the planes of the engine that must be sprayed (A=C=D=3 ft; B=6 ft)

Initial Design Concepts

- Focused on automated motion
- Allowed for variable, automated spray settings
- One nozzle systems

System Interface

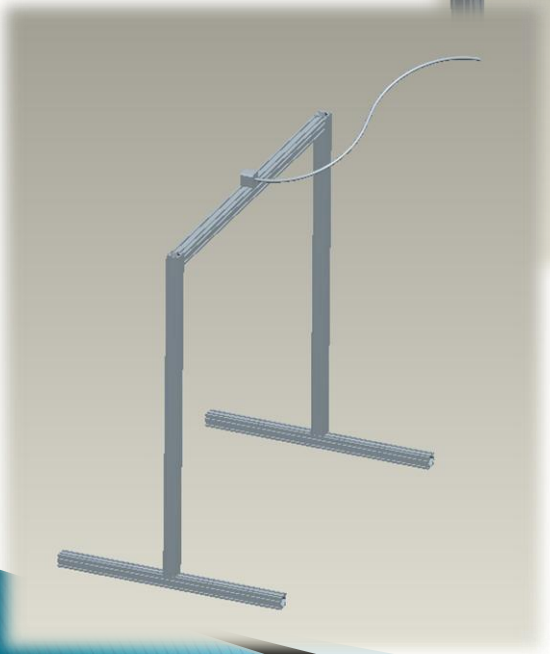
- Graphical User Interface
  - Lab View
    - Universal program
    - Ease of Use

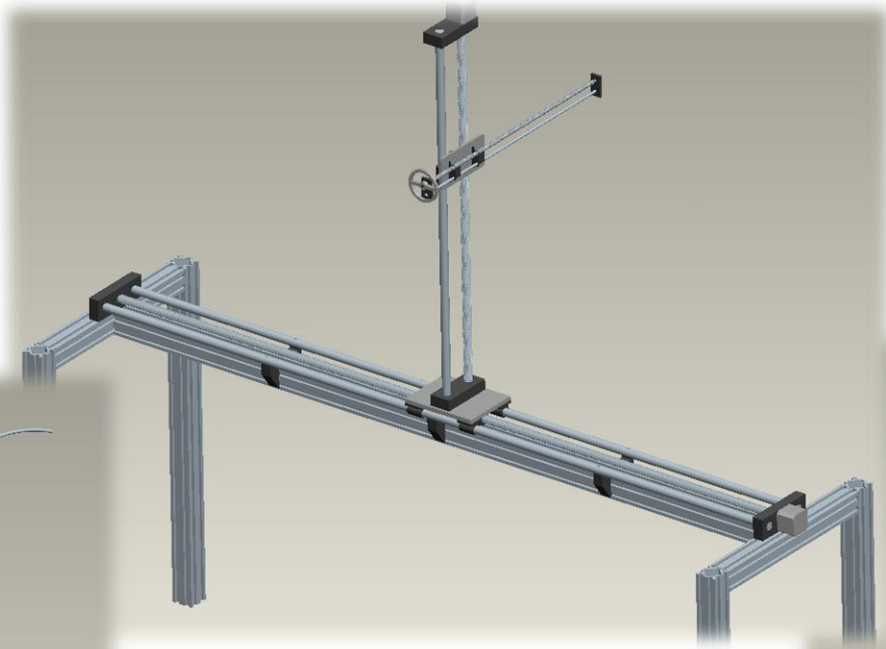


Example of Lab View front screen

Initial Design Concepts

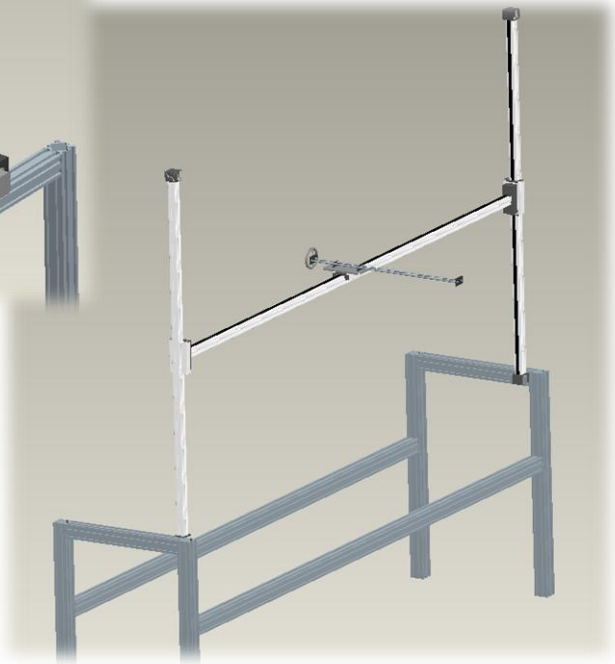
Flex Hose





X-Y Motion Table

Alternate X-Y Motion Table



Design Modifications

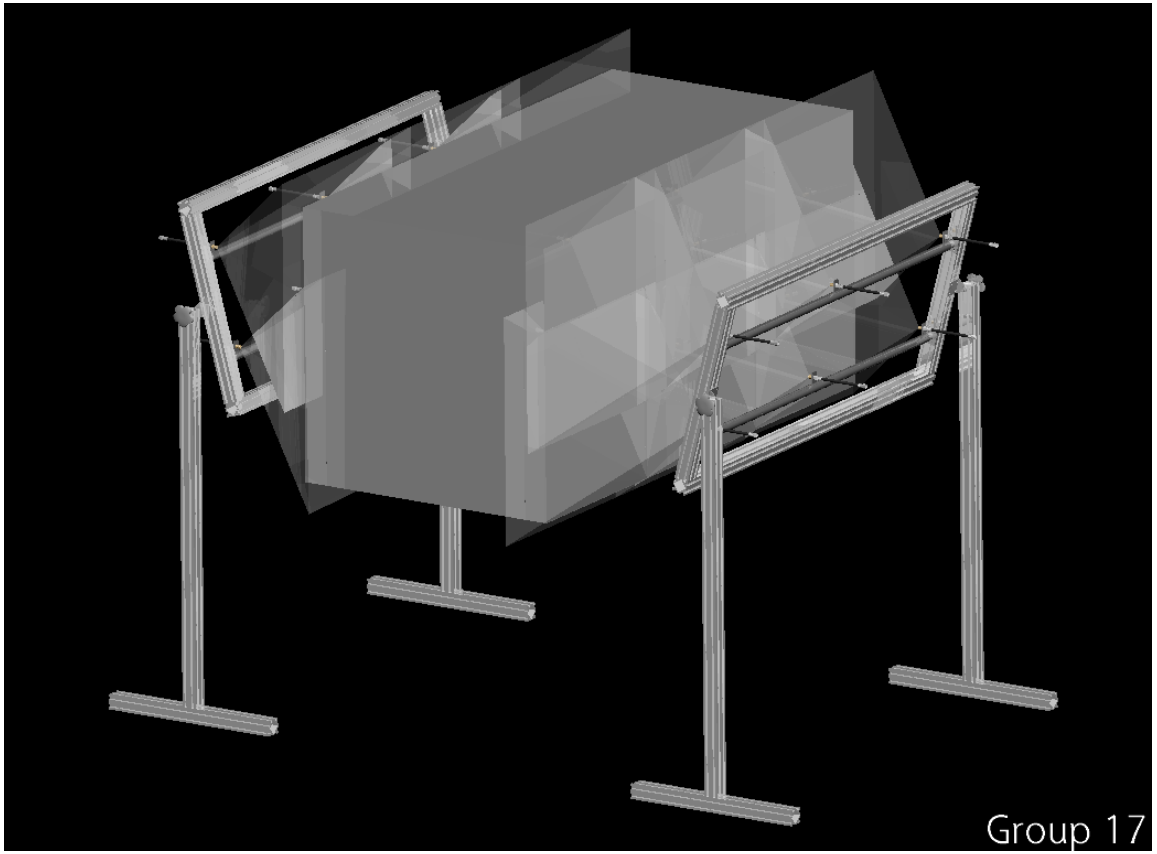
- Designs did not account for fatigue due to long engine endurance testing (1,000-4,000 hrs)
- Designs did not spray both sides of engine block
- Designs had only one nozzle spraying one component at a time

Re-design Considerations

- New design must be capable of spraying *entire* 18 square foot area *simultaneously*
- Automated motion not necessary nor desired
- Automate spray settings *only*
- Must be stable structure

Revised Design Concept

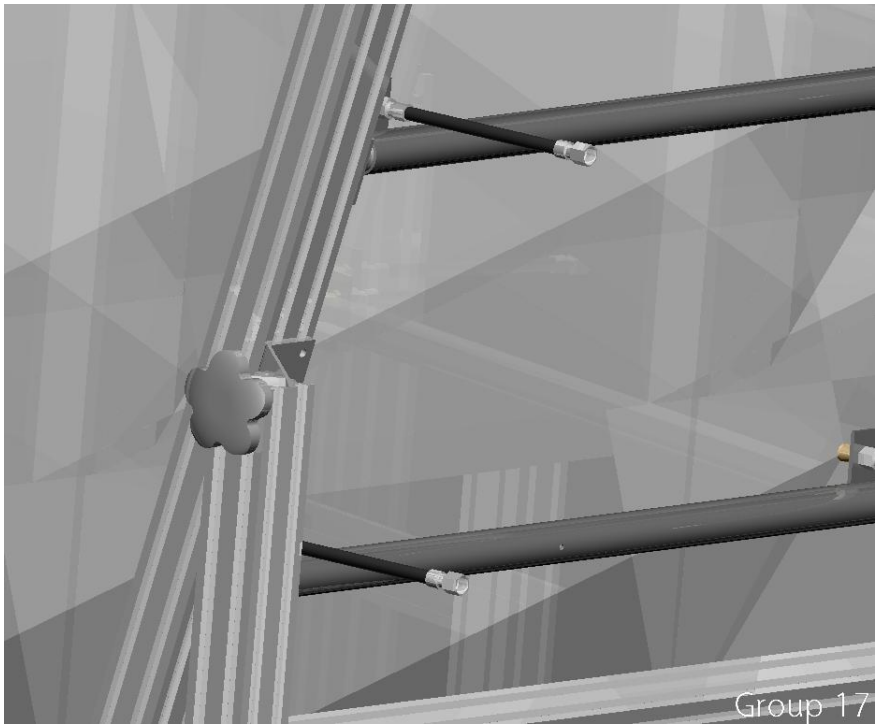
- General



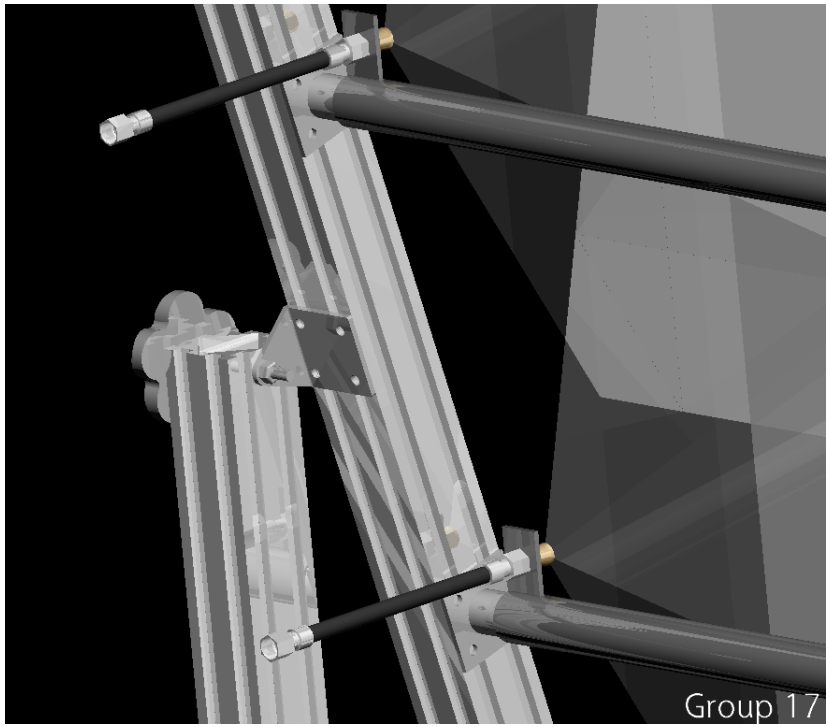
A general view of the system; the shadowed items represent the spray coverage of each individual nozzle

Revised Design Concept

- Position Adjustment



Anterior view of hinge mechanism

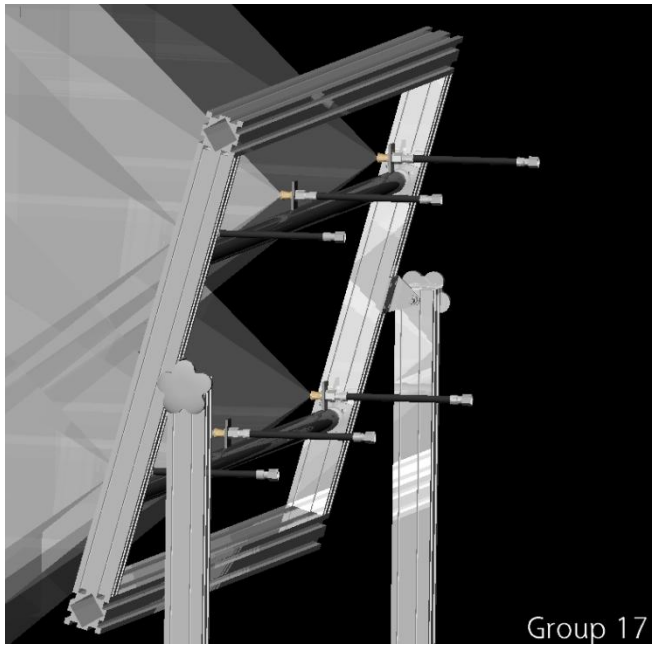


Interior view of hinge mechanism

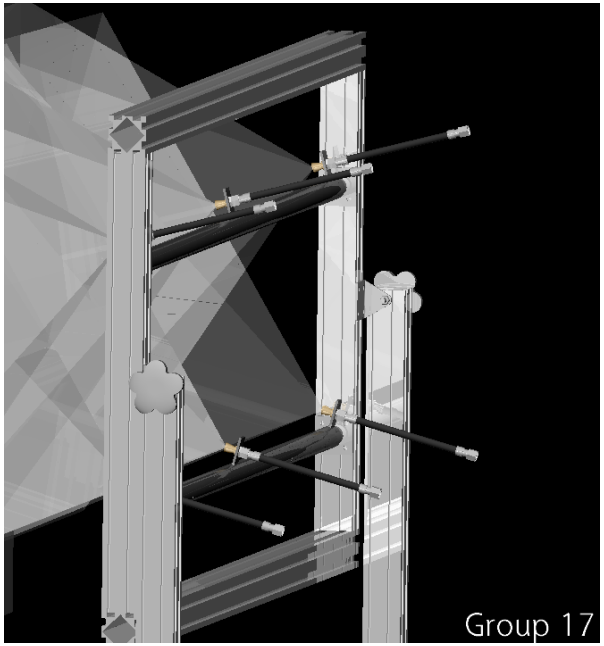
Hinge Mechanism allows for the spray structure to rotate. This is useful for different shaped engines such as V-configurations

Revised Design Concept

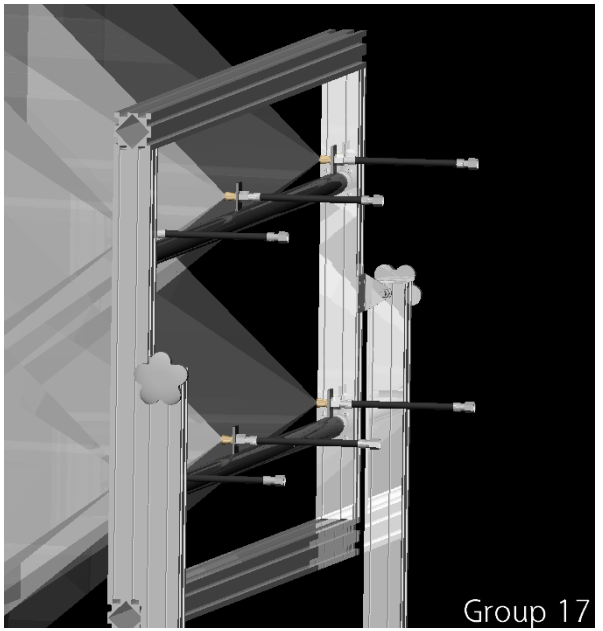
- Spray Adjustment



Frame Tilted
Nozzles remain Horizontal



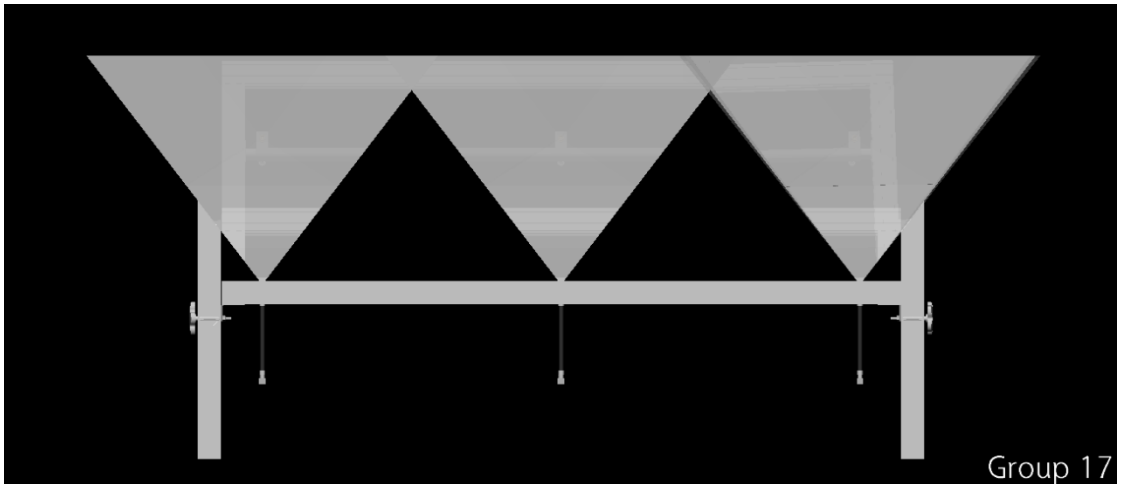
Frame Vertical
Nozzles Tilted inward



Frame Vertical
Nozzles Horizontal

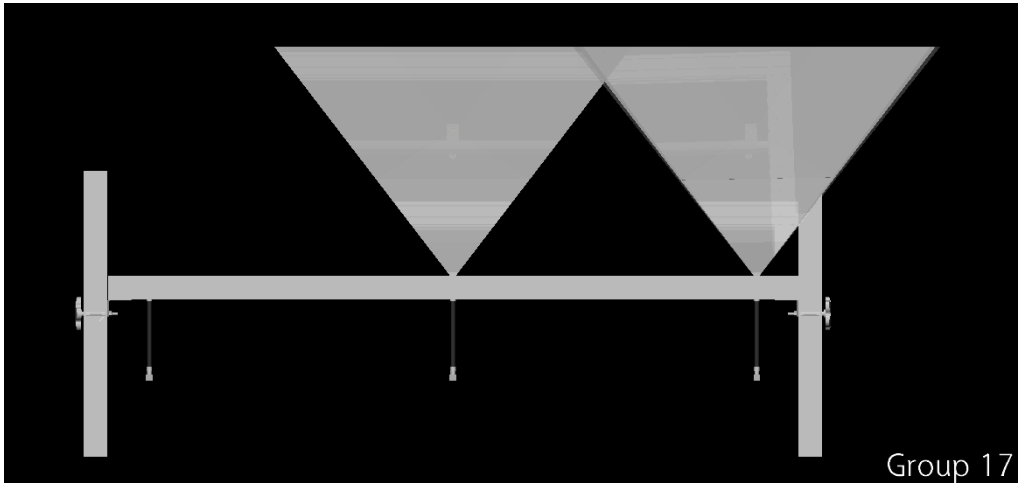
Revised Design Concept

- Spray Adjustment



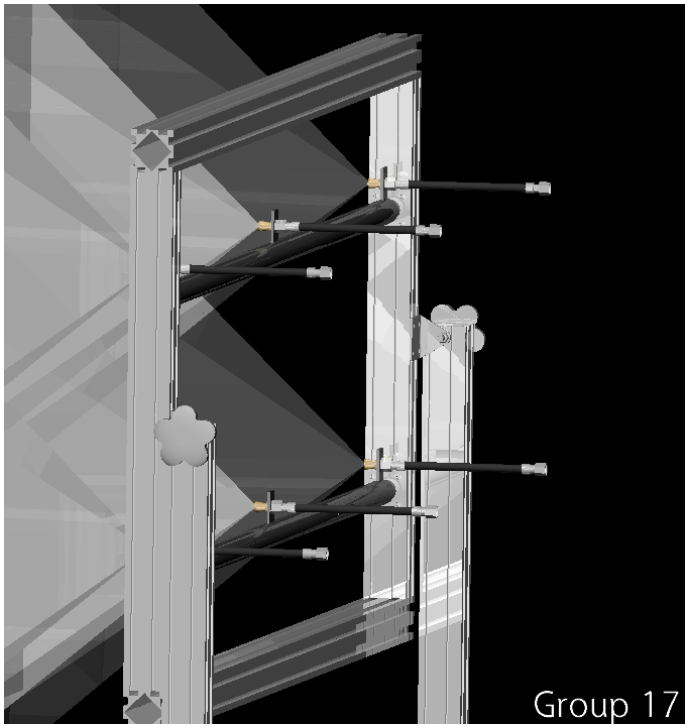
Left: Overhead view of all nozzle columns active

Right: Overhead view of one nozzle column shut off for more effective spraying

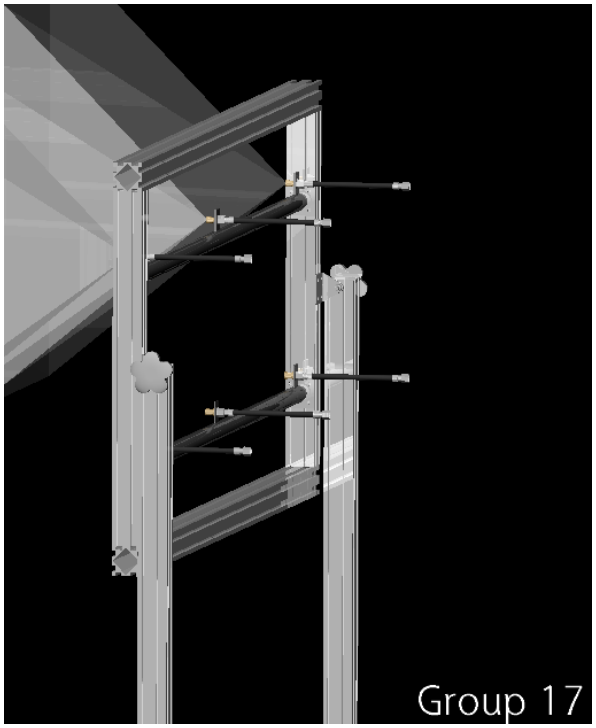


Revised Design Concept

- Spray Adjustment



Spray structure with all rows of nozzles active



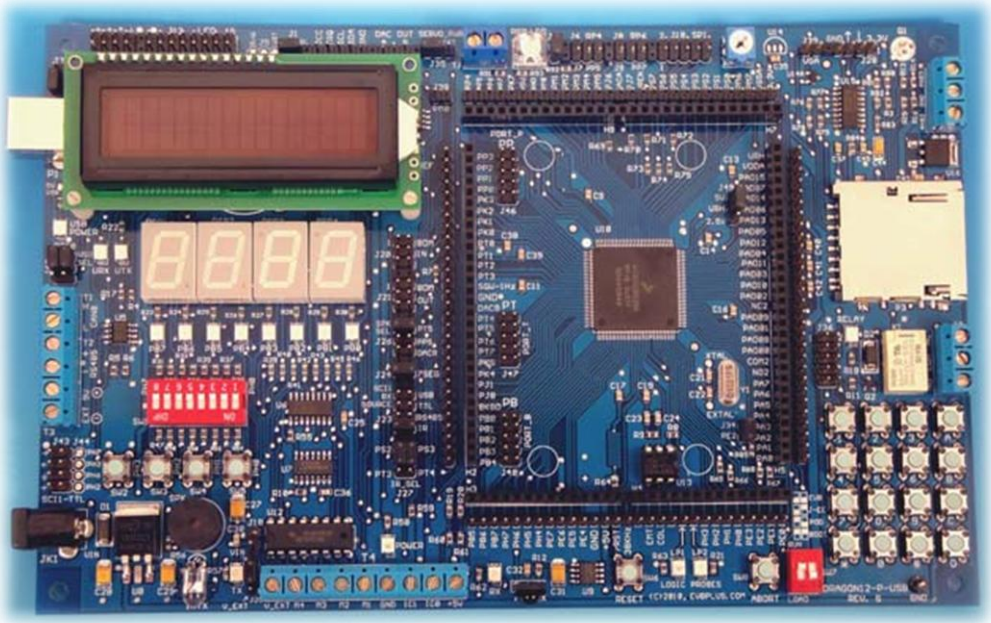
One row of nozzles shut off for more efficient spraying

Piping Structure

- PVC piping selected
- Calculated head loss of approximately 27 feet
- Maximum mass flow rate of 12 gpm
- Chosen pump meets calculated requirements

System Interface

- Control Board
  - Simple interface
  - Reliable
  - Stand alone system



Dragon 12-plus Control Board

Bill of Materials

Part	Unit Price	Quantity	Part Total
1-1/2" x 10' PVC Pressure Pipe	4.63	4	18.52
1-1/2" PVC Double Tee Junction	2.67	4	10.68
1-1/2" PVC 90° Elbow Junction	1.24	3	3.72
1-1/2" PVC Single Tee Junction	0.87	3	2.61
1-1/2" Clear Vinyl Tubing (per foot)	8.02	30	240.60
48" Framing Extrusion	18.24	10	182.40
L-Bracket	4.00	16	64.00
X-Vane-2 Piece- Square Nozzle	14.30	12	171.60
Sharkbite Fitting U140 1" Male Adapter	10.02	12	120.24
Extended Life Centrifugal Pump	737.84	1	737.84
Dragon 12-plus Control Board	149.99	1	149.99
Electrical Components	100.00	1	100.00
		TOTAL:	**1802.20**

Conclusion

- Re-design meets sponsor’s approval
- No automated motion
- Entire engine sprayed simultaneously

Future Work

- Utilize piping analysis program
- Finalize entire structure
- Purchase materials
- Assemble and test

A Special Thanks to…

- Mr. Alex Dugé
  - Cummins- Experimental Mechanics
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  - Cummins- Structural Analyst
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- Dr. Rob Hovsapian
- Dr. Srinivas Kosaraju
- FAMU-FSU College of Engineering
  - Mechanical Engineering Department

Questions?

References

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- Lowes Online <http://www.lowes.com/>
- Plumbing World <http://www.plumbingworld.com/>
- TecPro Nozzles <http://www.tecpro.com.au/>