

P08453: Turbomachinery Flow Visualization

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Project Manager

Sensors and Controls

Mechanical Design and Integration

Fabrication and Flow System Integration

Sponsored by: Dresser Rand


Project Description

- Develop an experimental apparatus to demonstrate fundamentals of turbomachinery
- Primary use will be as a teaching aid for RIT engineering students
- Customer Needs
 - Optically clear housing (View internal flow)
 - Interchangeable Impellers and housing
 - Measure pressure at pump inlet and outlet
 - Measure flow and modify resistance
 - Able to integrate high speed camera
 - Monitored and controlled through LabVIEW GUI

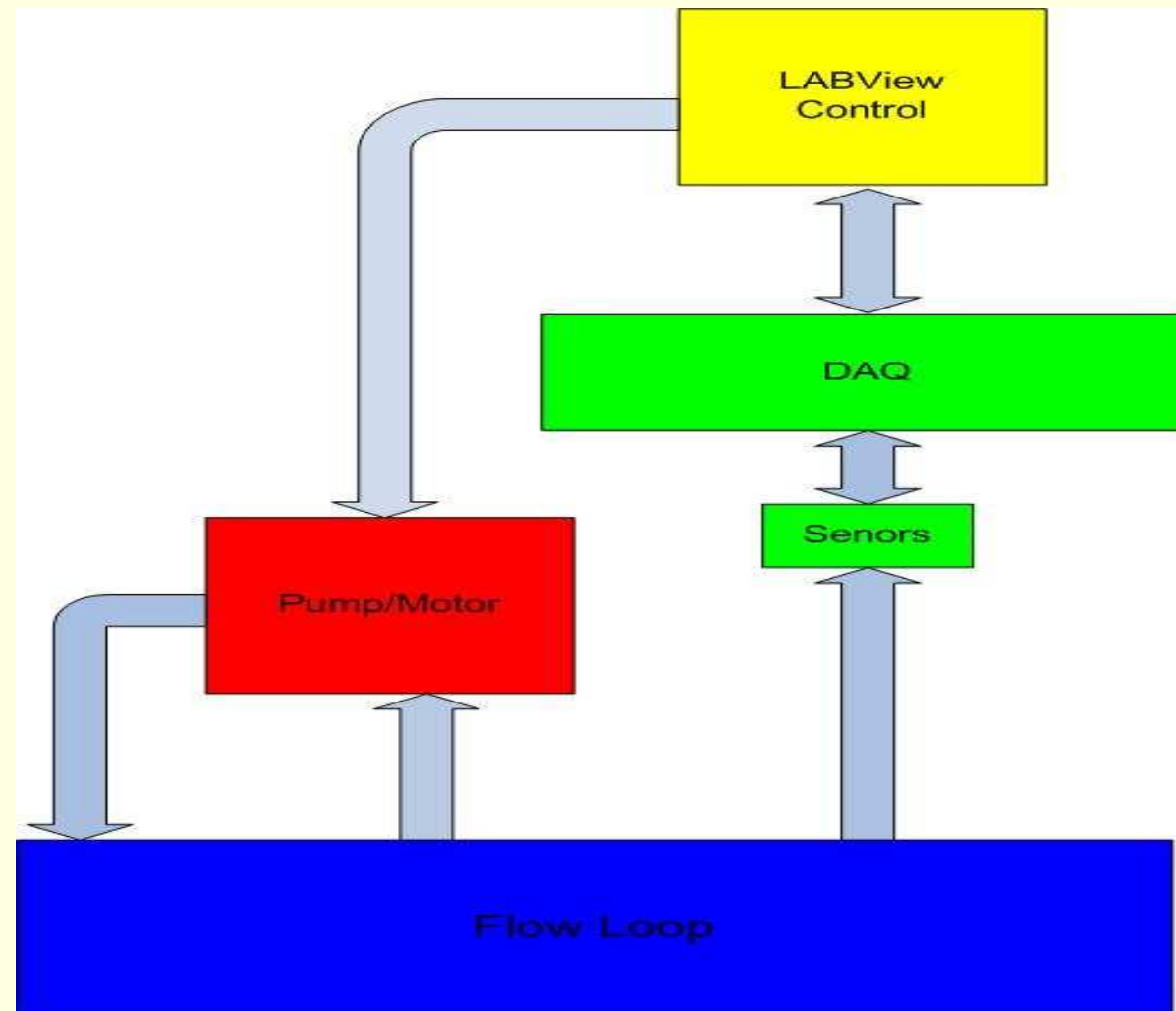
Design Specifications

Specification Number	Design Specification	Unit of Measure	Marginal Value	Ideal Value
1	Pump Housing is optically clear	Transmissivity	75%	>=85%
2	Able to change housing/impellers with minimal time	minutes	15	10
3	Impeller diameter	inches	4	4
4	Inlet and outlet pump differential pressure range	PSI	-	0-20
5	Inlet and outlet pump differential pressure can be monitored accurately	%Full Scale	1.50%	0.50%
6	Range of volume flow through the system	GPM	0-50	0-50
7	Volume flow through system can be monitored accurately	%Full Scale	1.50%	0.50%
8	Pump Temperature and Fluid temperature can be measured accurately	C	+/- 1	+/- 1
9	Motor RPM can be measured accurately	RPM	+/- 5	+/- 1
10	Pump vibration can be monitored accurately	Hz	+/- 3	+/- 1
11	Assembled test rig fits through standard sized door	inches	34	33
12	Accuracy of pump speed control	% Full Scale	1.5	0.5
13	Able to control pump speed within specified range	RPM	500-1750	500-1750
14	Able to capture high speed images of internal pump flow	Frames/sec	1000	2000
15	Test rig includes maintenance / cleaning documentation		yes	yes

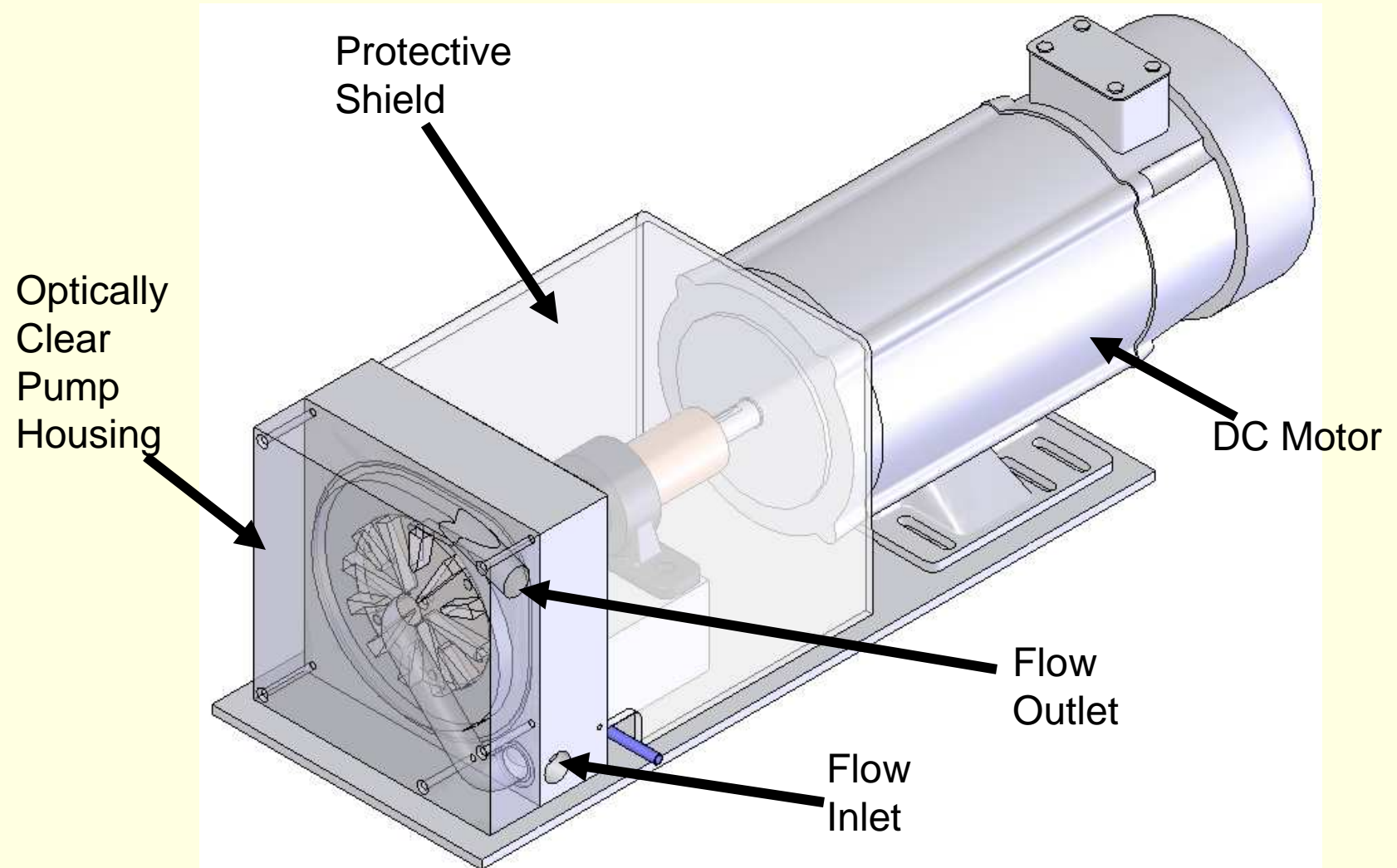
 Specification Met

 Specification may be met with different modular components

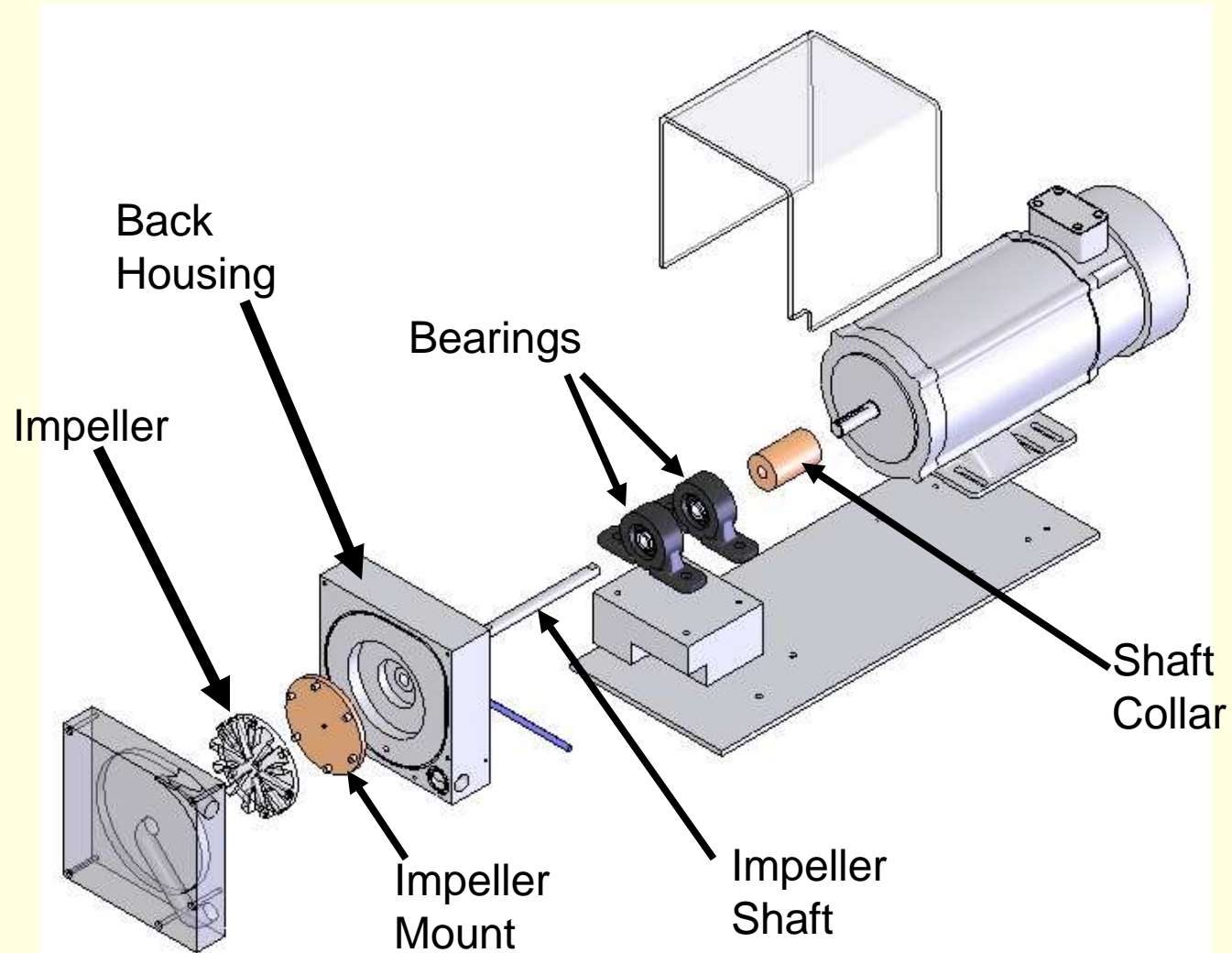
System Architecture



Design Concept



Design Concept

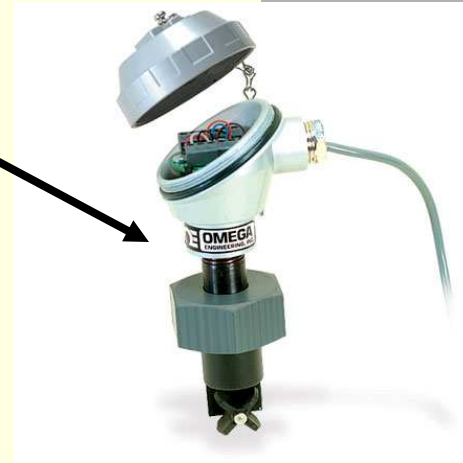


Sensors and Hardware

Pressure
Sensor



Flow
Meter



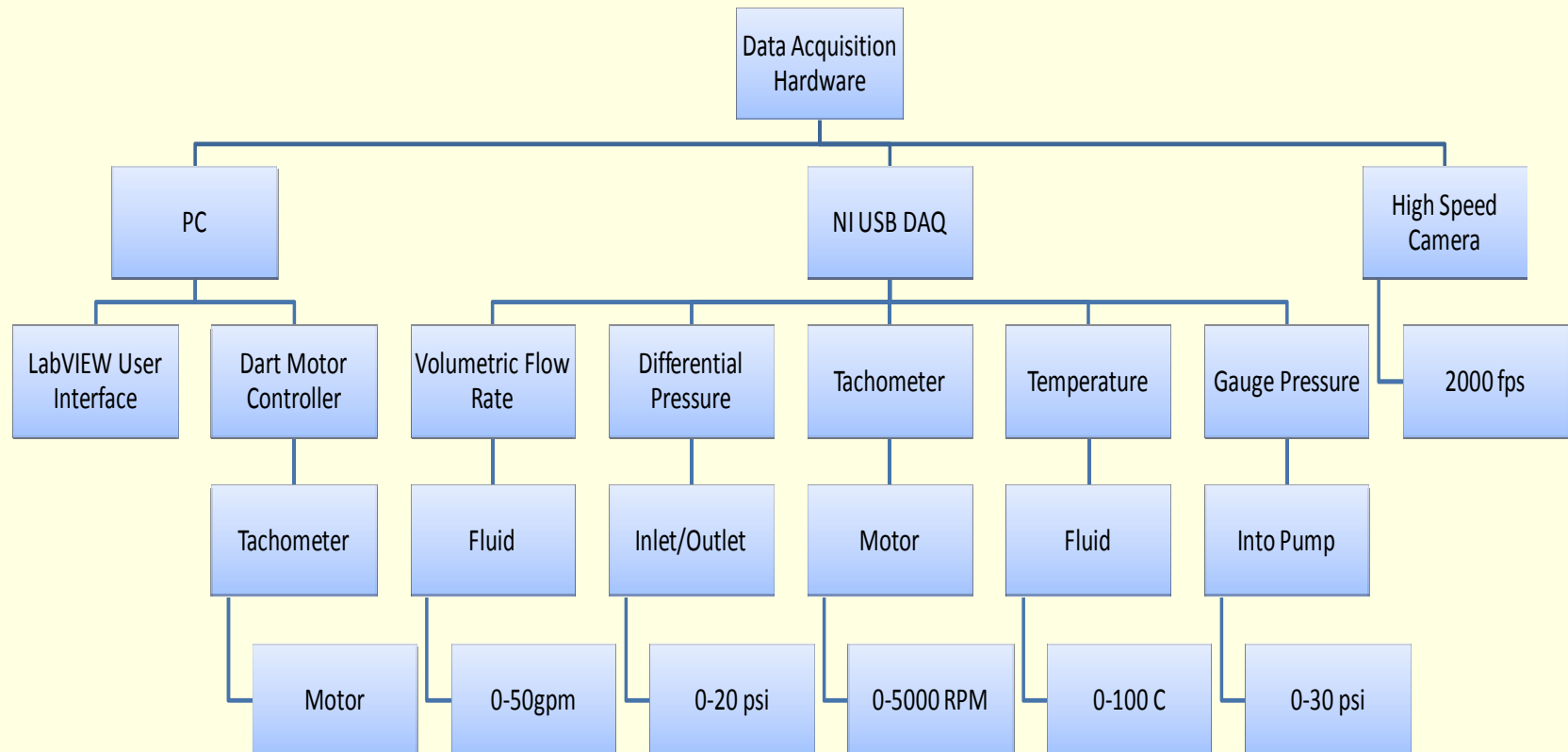
Motor
Control



DAQ



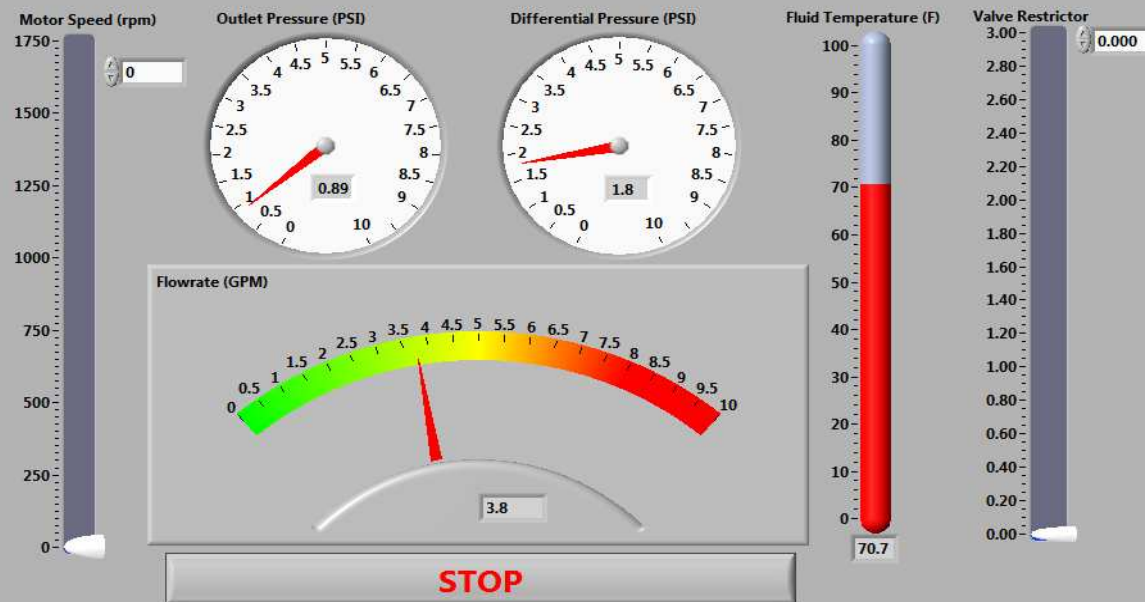
Control & Monitoring Architecture



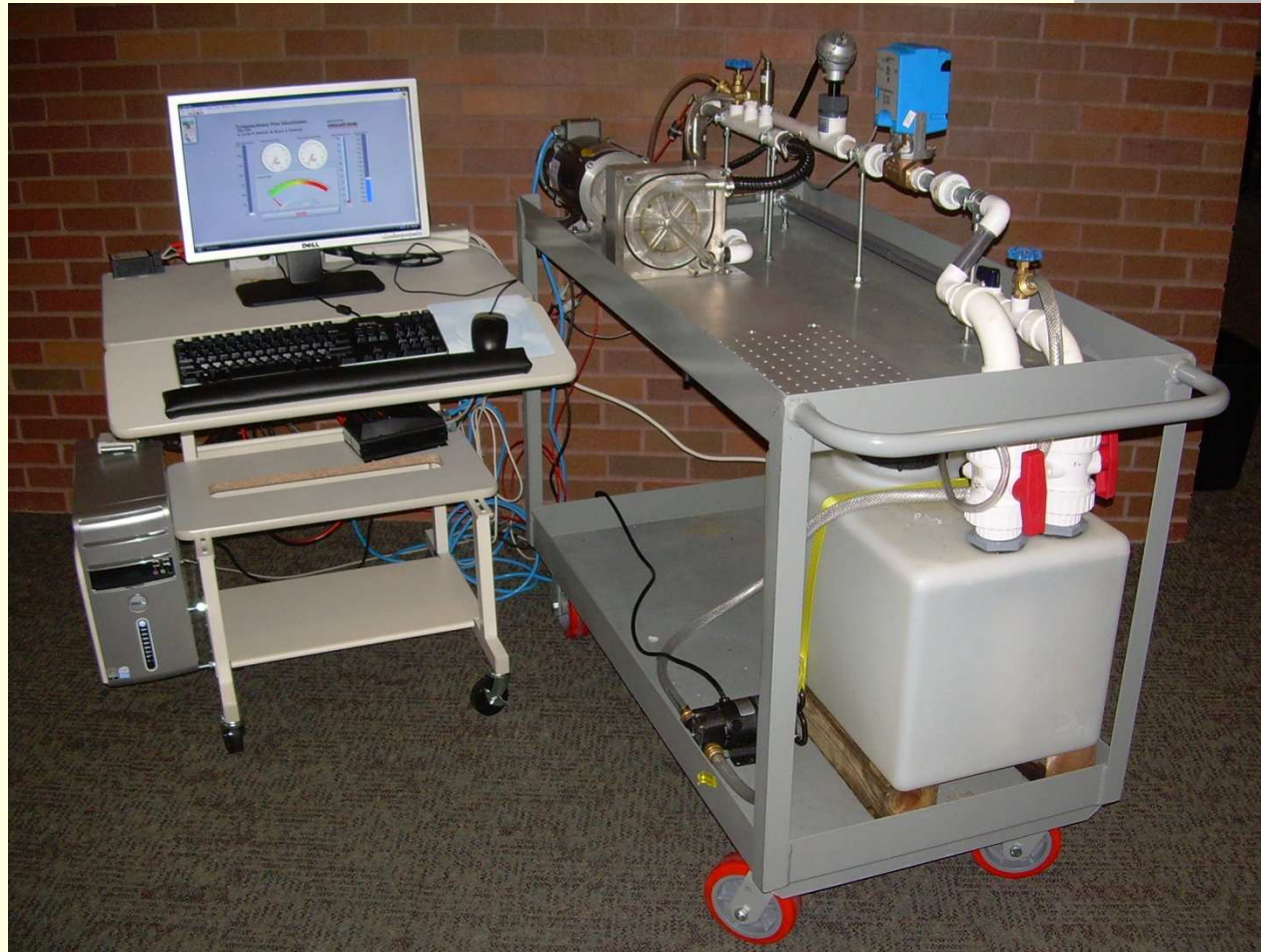
Computer Interface

Turbomachinery Flow Visualization
May 2008
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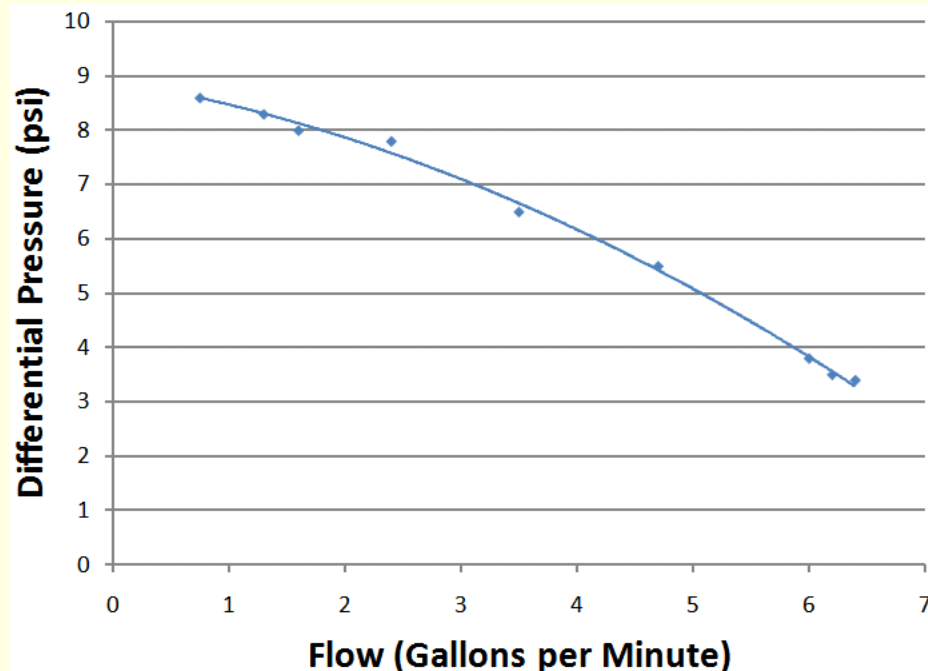


Integrated System



System Performance Specifications

- Pump Performance Specs not met by current system.
- Due to scaling a more complex system to a simpler one
 - Strait blade impeller vs 3D, complex geometry impeller
 - 2D vs 3D volute structure
- Can be fixed by replacing modular components
 - Faster Motor (2500 rpms)
 - Curved Blade Impeller

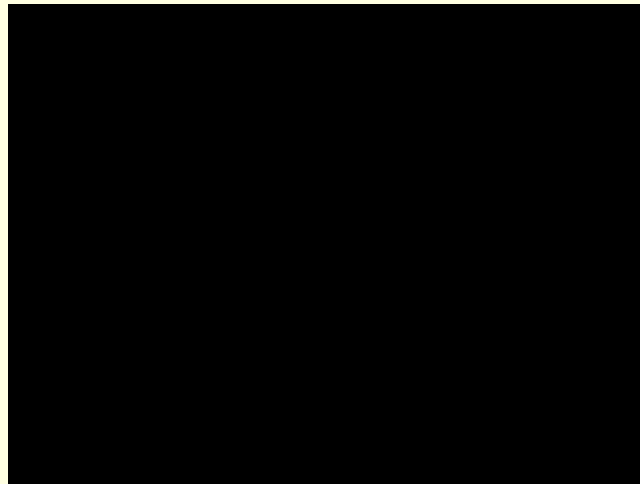


Internal Flow

- 1750 RPM
- 0.25 milliseconds
- Visualization verified



System Demonstration



Project Evaluation

- Design has met customer needs
- Design Specifications Fell short for pump system performance
 - Easily corrected due to modular design
- Project was behind
 - Testing was projected to occur in weeks 7 & 8
 - Prototype Functioning start of week 10
 - Delay in sensor delivery
- Budget: \$7000
 - Current cost of parts: \$5597.00
 - Remaining budget can be used to rapid prototype complex impeller designs
- Design issues
 - Pump housing does not seal entirely
 - Can be fixed with a gasket kit