

CENTRIFUGAL PUMP TEST
DATA ACQUISITION SYSTEM

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**CENTRIFUGAL PUMP TEST
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ABSTRACT

Yeomans Chicago Corporation manufactures pumps and pump equipment for both municipal and industrial wastewater applications. Yeomans' products include dry pit pumps, wet pit pumps, sump pumps, and submersible pumps which are tested in the company's facility before delivery to the customer. Pump performance is analyzed by plotting flow capacity against head and brake horse power for set motor speeds to calculate pump efficiency. The test is run at shutoff (meaning 0 gpm), to ensure no wearing on the impeller, then at several other operating points, including the duty point (flow rate that client will run pump at) to verify that the pump performs at its promised efficiency. Efficiency is calculated using data collected by a Data Acquisition System (DAS) that is interfaced with a variety of sensors integrated within the pump test setup. Yeomans desires that the current centrifugal pump test DAS software and hardware be replaced by a PC-based DAS. The new DAS will improve accuracy and confidence in test results, decrease transfer time of data for analysis, and most importantly reduce delays in shipping due to testing problems. Custom software, to be determined, will be designed to manage data collected by the newly installed DAS. Contingent on Yeomans' acceptance of the proposals, the new DAS will be implemented on location and tested prior to completion of project. Yeomans requires that installation and start-up on-site supervision and training be provided.

KEYWORDS: data acquisition, DAS, centrifugal pump, transducers, signal conditioning, Himmelstein, head

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Introduction

Yeomans Chicago Corporation manufactures pumps and pump equipment for both municipal and industrial wastewater, sewage, sludge, and light slurry applications. The company produces Yeomans Pump, Chicago Pump and Morris Pump brand centrifugal pumps including traditional dry pit non-clog solids handling pumps, wet pit pumps, sump pumps, and submersible pumps. Pumps manufactured by Yeomans are tested prior to shipment in the company's facility in Aurora, IL on one of the four separate testing setups. The 4 setups include a submersible center, and 3 dry pit setups containing closed loops of varying pipe diameters. Each of these four test centers are connected to sensors that take measurements that are relayed to a central DAS which converts the measurement into an input signal to be interpreted.

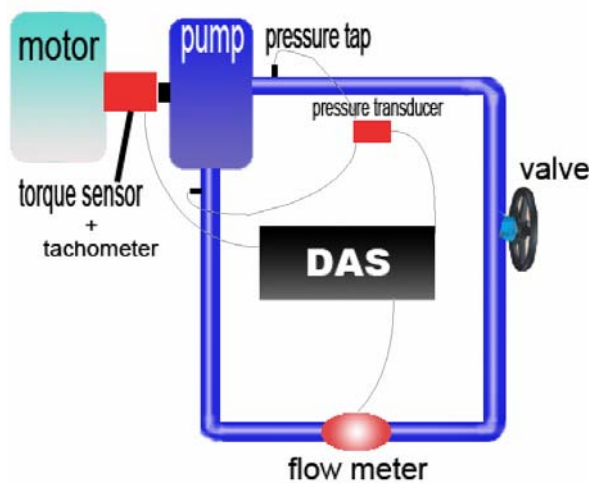


Figure 1: Test Setup Schematic



Figure 2: DAS Data Flow Schematic

As shown in Figure 1, a motor is connected to a pump by a shaft containing a torque transducer and tachometer. On both sides of the pump there are pressure taps to measure the head added to the water by the pump. The pump is attached to a closed loop system of pipes which contains a flow meter and a valve used to set different flow rates for the purpose of testing. All of the sensors interface with the DAS. Figure 2 shows how the sensors (located in the top left of the picture) output their signals through shielded cables to a signal conditioning box which filters out noise and adapts the signals to be read by the data acquisition card (DAQ card). The DAQ card accepts the signals which the software deciphers and converts into data files. The data is converted to graphical format and is printed for the client and saved to an HP formatted disk.

The DAS currently being used at Yeomans Chicago Corporation pump testing facility is the Himmelstein System 6, which was installed in 1985, shown in the following picture.



Figure 3: Himmelstein System 6 DAS

When a test is run, the DAS takes from 7-10 measurements from the sensors and performs calculations from those measurements to determine the pump's performance. The accumulated performance data consists of flow capacity, head, horsepower, and efficiency at the tested speed. Pump performance is analyzed by plotting flow capacity vs. total head added, brake horse power, and efficiency for a single, client-specified, motor speed. Before shipment of the pump, the specifications promised to the client at the point of sale must be surpassed by the pump's actual performance in the test.

Yeomans has low confidence in the data produced by the DAS since it has exhibited questionable accuracy and varying results on multiple occasions. Low confidence levels in the current system make it difficult to determine whether the errors result from the outdated DAS, physical components of the loop, or the pump. Since there is a possibility that the unsatisfactory test data reflects poor pump performance, the pump must be retested. The setup time associated with testing one pump can be up to 4 hours, which is a costly problem for Yeomans. In addition to this, since poor test results force Yeomans to perform redundant tests, shipping delays are common. An unsatisfied customer will often link shipping delays with an unreliable vendor.

Data management is also a problem with the DAS currently in use at Yeomans. The Himmelstein System 6 saves its data to an HP formatted disk that must be converted to a windows format. Then, through the use of spreadsheet software, a graphical representation of the data is

created and scaled to one sheet of paper. The tedious data management process takes one worker approximately 30 minutes to complete. Since 2-8 tests are run per week, this counts for 1-4 hours of work that can be eliminated by implementing an updated DAS.

Although 1-4 hours of work is an important improvement, the real economic benefit realized is in the increase of accuracy of the test results. The increase of confidence in the test results will lead to less retesting and a decrease in the amount of shipping delays due to retesting needs, meaning a large economic impact for the company.

Problem Statement

Yeomans Chicago Corporation desires that its current pump test Data Acquisition System (DAS) be replaced by a new PC-based DAS subject to the following criteria:

1. The capabilities and shortcomings of the current pump test DAS must be analyzed.
2. The new DAS will incorporate Resistance Temperature Detectors (RTDs), thermocouples, amp meters, volt meters, and 3 phase kW meters, in addition to all current sensors.
3. The new DAS should consist of standard components that are easily replaceable.
4. Proposal of new hardware will be supported by economic analysis.
5. The new DAS must produce standard pump performance and efficiency curves, as well as archival of data.
6. The new DAS will be implemented on location and tested prior to completion of project.

Objectives

It has been determined that the following objectives are necessary for the successful completion of this project:

1. **Analyze the current test setup.** Evaluation of all current components proficiency to perform tasks, and observation of testing procedure.

2. **Additional hardware component.** RTDs, thermocouples, amp meters, volt meters, and 3 phase kW meters are the additional sensors that need to be incorporated into the system. These components must be identified as compatible with the DAS to be developed.
3. **Propose new hardware and software.** After researching all components necessary to construct a DAS a proposal to purchase will be delivered to Yeomans.
4. **Purchase of approved components.** After proposal, components will be purchased and sent to University of Illinois for construction.
5. **Design custom software interface.** A software application must be customized to perform tasks desired by Yeomans, be intuitively easy to use, and archive data
6. **Construction of DAS.** The new DAS will be constructed at the University of Illinois and tested by using simulated inputs that mimic the sensor outputs at Yeomans.
7. **Install DAS on location.** The new tested DAS will be implemented in the test facility, and performance will be tested and verified as accurate.
8. **Training.** On-site supervision and training will be provided to Yeomans employees in addition to a user's manual that will be provided for the new system.
9. **Economic analysis.** The return on investment of this project will be calculated based on the solutions it provides to their current problems.