**Enhancing Laboratory Efficiency through Continuous Quality Improvement and LIMS Automation**

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# Enhancing Laboratory Efficiency at an Energy Utility through Continuous Quality Improvement and LIMS Automation

## Introduction

KeySpan Energy is the largest investor-owned electric generator in New York State and operates Long Island's electric system serving 1.1 million customers. KeySpan's laboratory is responsible for a number of analyses including natural gas leak analyses, industrial hygiene, air quality, fuel oil quality, hazardous materials, wastewater discharge analysis, and permit compliance. In many situations, the turnaround time from sample collection through laboratory analysis to final reporting is critical and laboratory managers need to be able to make informed decisions based on test results. The laboratory consists of two sites, the main site in Brooklyn, NY (Brooklyn Union Gas) and a second site (Long Island Lighting Company - LILCO) located in Glenwood, NY.

As a result of an internal quality needs analysis, KeySpan determined that they needed a laboratory information management system to increase productivity and enhance the quality management system already in place. The laboratory sought a LIMS that met their specific data management needs. Some of these requirements were a Windows-based system and compliance with NELAC (National Environmental Laboratory Accreditation Conference) and GALP (Good Automated Laboratory Practices). KeySpan selected Accelerated Technology Laboratories, Inc. because of their expertise and experience in environmental data management and Sample Master® Pro LIMS to meet their specific data management needs.

This paper will describe KeySpan's laboratory sample flow, bottlenecks, the implementation of the laboratory information management system and the resulting automation improvements.

## Data Management Needs

KeySpan Energy performed an internal quality needs analysis in order to evaluate their automation needs. The Quality Group performing the analysis was composed of a quality engineer, laboratory managers and engineers. The group's mission was three-fold: 1) to focus on the laboratory's sample analysis process to determine ways in which report turn-around times could be reduced, 2) the enhancement of data quality (i.e. decrease transcription errors); and 3) the implementation of processes to accelerate the automated delivery of validated and approved results. The in-depth analysis was critical for the laboratory managers in understanding the laboratory operations and functions at a very detailed level.

The first step in the quality needs analysis was to outline the current sample flow through the laboratory along with its data management and final reporting of results. A series of customized queries were created to measure user defined specific process points in the sample flow analysis. These queries were then analyzed for information on turnaround times during the various stages of sample analyses, they provided a report with time-stamps for each section from sample login, to analysis, to final reporting. KeySpan learned from the data analysis that the greatest loss of time occurred between sample login and result entry. The time lapse was about 8.7 days, out of 10.97, on average for a period of 6 months. Further analysis demonstrated that there was no direct correlation between the number of samples analyzed and turnaround time.

In referencing this data, the team focused on the root causes of the poor turnaround time occurring between sample login and result entry by using proven quality tools such as brainstorming, cause and effect diagrams depicted in *(Figure 1),* and interrelationship diagrams in combination with the reports of turnaround times for each section in the laboratory. The activities allowed the Quality Group to generate numerous solutions.

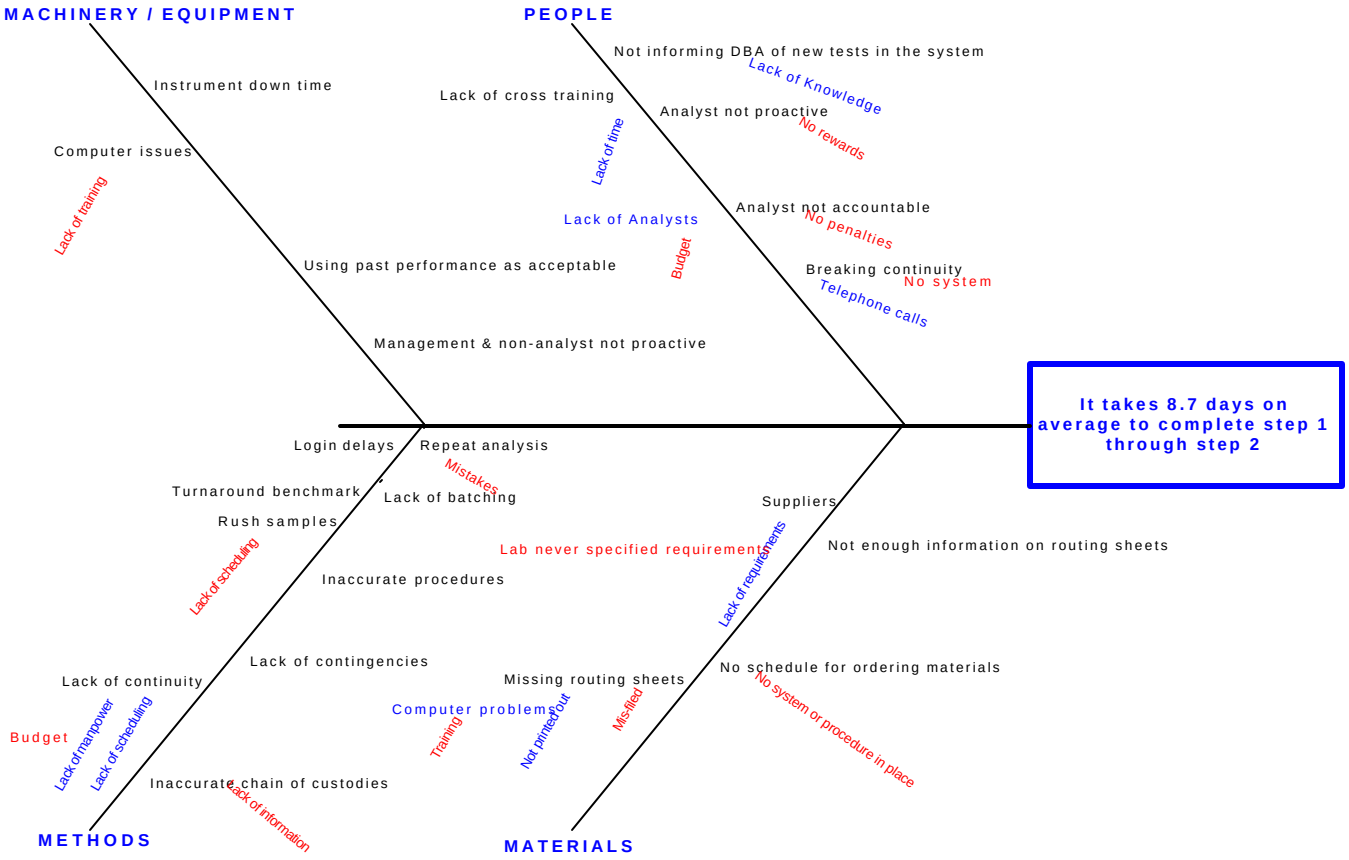



**Figure 1 Cause and Effect Analysis of Laboratory Bottlenecks**

The above cause and effect diagram, otherwise known as a “fishbone” diagram, allowed the KeySpan Quality Team to systematically identify and display all the possible causes related to the bottleneck in the turnaround time process. The four main categories identified included; machinery/equipment, people, methods and materials. Examples include the need for up-to date training on the instrumentation and associated software and LIMS (as there were new analysts in the laboratory that required training), ability to perform the same or greater analysis with fewer resources, and interrupting telephone calls to the laboratory requesting test results, as they are trying to perform the analyses.

These are just a few of the examples of what the fishbone diagram revealed. Solutions to these issues included, providing training to the chemists on the instrumentation and LIMS. Performing more analyses with fewer resources was addressed with the LIMS, instrument integration, and auto-reporting features. Laboratory personnel were shielded from multiple calls requesting test results by establishing accounts for remote users to retrieve the sample status and test results in the LIMS by using the LIMS Explorer via the web. The results of this root cause analysis, as well as the automation enhancements post acquisition are classified in Table 1.

**Table 1. Results of the Root Cause Analysis Performed at the Laboratory**

| Causes for Bottlenecks | Target Areas for Improvement | Resolutions |
|---|---|---|
| 1) Rush Samples<br>2) Improper Chain of Custody | Internal Process Control Review | - Implemented bar-coded labels in LIMS<br>- Provide proper training to all end users<br>- Capability to track specialized chains of custodies in LIMS |
| 1) Outside Laboratories' Turnaround Time | Automation Enhancements & Vendor Partnerships | - Automatic importing & exporting of results from contract laboratories<br>- Audits suppliers' practices<br>- Required copies of their certifications<br>- Provide them with required information<br>- Review proficiency test results |
| 1) Lack of Cross-Training (instrumentation, LIMS, methods, etc.) | Human Issues | - Perform a training needs assessment and formulate a detailed plan to meet those needs<br>- Record analyst training records in LIMS |
| 1) Need computer system upgrade<br>2) Lack of Instrument Backups<br>3) Lack of training/utilization of software | *Automation Enhancements | - Upgrade computer system hardware and software in order to run LIMS software and achieve maximum production.<br>- Installation of LIMS Faxing software, auto faxing, and auto-reporting (e-mail)<br>- Implement a plan for regular instrument backups and provide training on the process.<br>- Perform a needs assessment that encompasses a broad range of laboratory training needs, such as use of LIMS software and instrumentation.<br>- Send analysts to LIMS training course |
| 1) Instrument maintenance | Track calibrations | - Use of LIMS to track and remind analysts of required calibration and maintenance (proactive instrument management) |
| 1) Incomplete routing sheets<br>2) Request for sample form needed | Documentation | - Implement folder review system<br>- Properly train associates<br>- Fully Utilize LIMS Sample tracking module (sample conditions and chain of custody functionality) |

**Implementation of Automation Features**

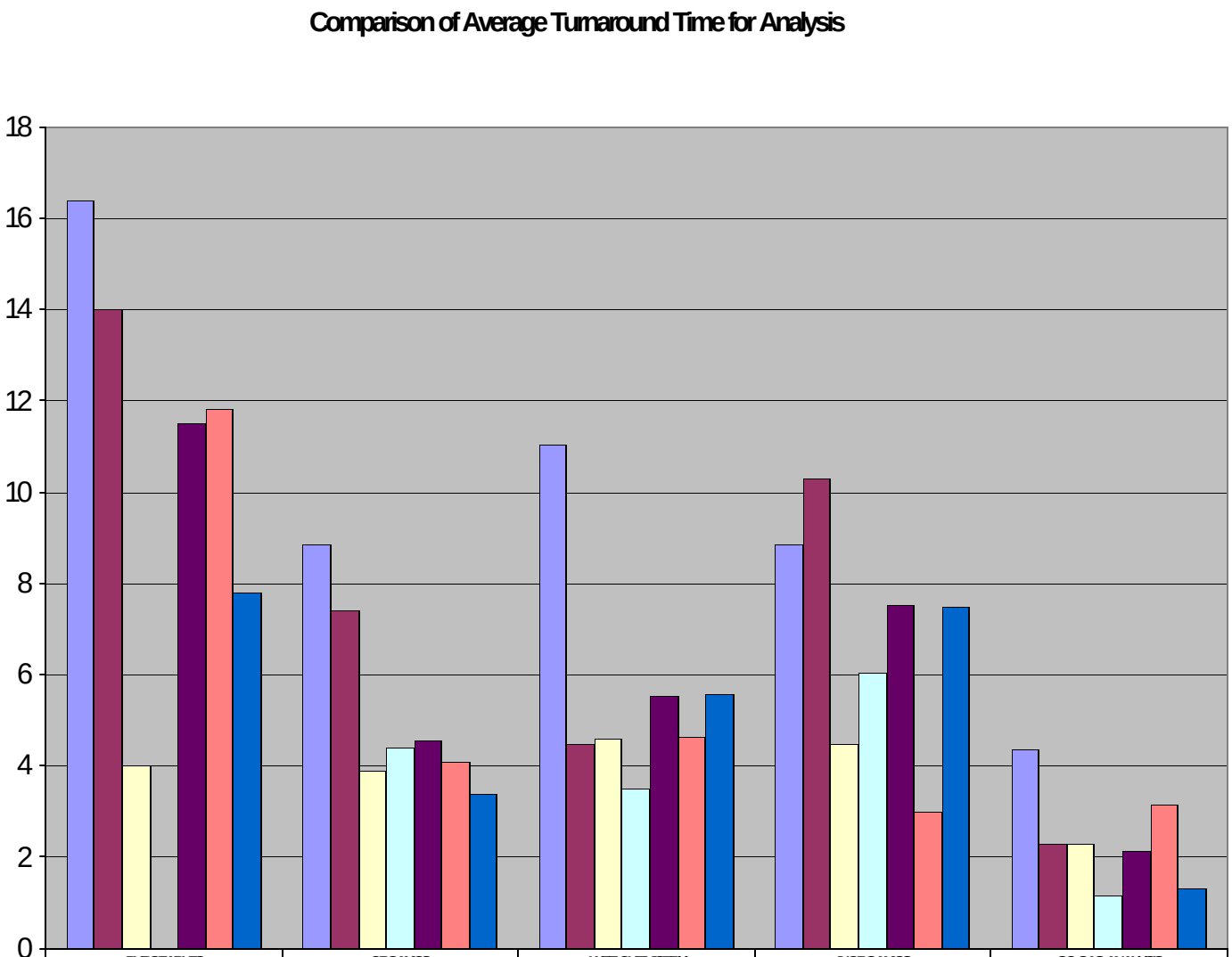
Based on the outcomes of the needs assessment, KeySpan prioritized the issues and began implementing resolutions. Following the merger of the two KeySpan laboratories (Brooklyn Union and LILCO, Glenwood, NY), certain changes in the operations warranted an enterprise wide solution that would connect them into the central database over a WAN (Wide Area Network). This would have several benefits, tying the laboratories together since they often split samples, require maintenance of only one database, increase communication between sites (ensure consistent operations) and put the framework in place for future growth. With the laboratories now connected, more internal changes took place. KeySpan purchased a new server and several additional software products (LIMS Explorer, Adobe, FAX Master). KeySpan also worked with the LIMS vendor to incorporate some customized features and functionalities such as auto-faxing, bar-coded label printers, hand held scanners, instrument integration, read only reports that could be e-mailed and web access to the LIMS.

One of the customized features that KeySpan incorporated was software that allowed the laboratory to automatically fax and simultaneously print reports to clients upon final validation and approval in the LIMS, the printed copy was the laboratory's copy. This dramatically cut down on the human intervention required to fax out reports. In the past, data had to be validated and approved in the LIMS and then a hard copy printed that was signed by the laboratory supervisor. This copy was delivered to an administrative assistant that faxed out the report. There are several steps in this process and busy fax lines had to be re-sent which chipped away at overall productivity and increased turnaround times. The supervisors that had approval authority on reports provided signature samples which were digitized and integrated into the LIMS reports, so that once they approved a sample result, their name (electronic digitized signature) was inserted into the report. The report would automatically go to the printer and the faxed copy would be sent directly from the LIMS.

The benefits of the auto-faxing feature were obvious and prompted KeySpan to examine other areas where technology could decrease manual entry time. One such area involved the manual entry of analytical instrument data into the LIMS. Manual entry was manageable when the sample volume was low; however as the sample volume increased, this became a bottleneck. Integration of the LIMS with the instrumentation was a logical step in the elimination of the bottleneck. Three instruments which were interfaced include Perkin Elmer's ICP Optima 33COXL, GC and a GCMS. In addition to eliminating the mundane task of hand entering the instrument results into the LIMS, additional benefits included the elimination of transcription errors that translated to higher data quality and a decrease in turnaround times. There was also an increase in efficiency and productivity since the data was now directly transferred to the LIMS following analysts review. KeySpan also eliminated the need to manually enter all results from outside contract laboratories by placing electronic spreadsheets into a directory scanned at user definable times by the LIMS with automatic data import. The utilization of this function, which eliminated transcription errors, enhanced data quality and freed resources previously required to key in this data.

KeySpan also wanted to incorporate LIMS technology to benefit their customers. Because of the nature of the energy business, analytical test results must be delivered rapidly to the appropriate client, since in many cases those results dictate operational activities. In an effort to make results readily available throughout the organization in real time, KeySpan incorporated LIMS Explorer software that allowed the LIMS to be web enabled and offered users 24/7 access to the data over a secure web site with a username and password required for system access. The addition of this feature satisfied their internal customers need for immediate access to test results and provided sample status updates.

## Results




| | PURGEABLES | ORGANICS | WET CHEMISTRY | INORGANICS | GC GAS ANALYSIS |
|---|---|---|---|---|---|
| Six Month Average | 16.39 | 8.83 | 11.05 | 8.83 | 4.36 |
| May | 14 | 7.4 | 4.5 | 10.3 | 2.3 |
| June | 4 | 3.9 | 4.6 | 4.5 | 2.3 |
| July | | 4.4 | 3.5 | 6.05 | 1.15 |
| August | 11.5 | 4.56 | 5.53 | 7.53 | 2.13 |
| September | 11.8 | 4.08 | 4.62 | 3 | 3.16 |
| October | 7.81 | 3.37 | 5.56 | 7.49 | 1.33 |

**Figure 2 Comparison of Average Turnaround Time for Analysi s**

After implementing various resolutions, the Quality Group began to measure each section of the laboratory's turnaround time against the six-month average turnaround time prior to the analysis. (Not included in this measure was the turnaround time from outside contract laboratories as that was not under the laboratories control.)

After implementing the recommendations, the team started to measure each section of the Laboratory's turnaround time against the six-month average turnaround time prior to the analysis. As can be

observed in Figure 2, the turnaround time improved in every category for the next 6 months measured. However, an exception was detected which occurred in the inorganics area for the month of May. Fortunately, the team was able to determine the problem which was failure of an instrument. After finding the hardware problem, a solution was implemented. Also, depicted on the chart, was the fact that there was not enough data to apply a measure for the month of July in the Purgeables area. It is important to note that these are immediate improvements and that the goal is to further decrease turnaround times and continually improve data quality. The laboratory will continue to track and monitor progress.

The data in this illustration shows that there is variation in the process, but the process is consistently better than prior to the analysis. LIMS features that were responsible for the improvements included generating bar-coded sample labels, utilization of auto-reporting, auto-faxing, instrument integration and the implementation of electronic signatures. The laboratory also migrated to the enterprise LIMS edition based on Microsoft SQL Server from Microsoft Access to accommodate the larger data volume from the merger of the two laboratories. Microsoft SQL Server is ideal for databases that hold large sample volume (i.e. 100,000 samples) allowing laboratory managers to analyze multiple year's worth of data.

Another improvement was the integration of subcontractor laboratories data deliverable to the KeySpan laboratory in an electronic format that could automatically be uploaded to the LIMS, eliminating transcription errors and eliminating double entry time.

**Conclusion**

In conclusion, KeySpan Energy successfully implemented a laboratory information management system that helped them meet their automation goals which included improvements in turnaround time, increased production and customer satisfaction, reallocation of resources and improvements in overall efficiency. KeySpan was able to successfully implement a LIMS solution by first analyzing their internal processes and performing root cause analyses based on their findings. The flexibility of the implemented LIMS has provided the laboratory with the mechanisms to meet their future automation goals. There is a system in place to monitor and measure the process in real time, thereby allowing for support of future continuous process improvements.

**Additional Reading:**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