DRIVING TREATMENT PLANT PERFORMANCE – IMPLEMENTING THE DASHBOARD

Vitek Wilewski, City of Toronto, Water Pollution Control

Terry Brueck, EMA Services, Inc.

Claude Williams, EMA Services, Inc.

Abstract

The City of Toronto Works and Emergency Services Department embarked on the Works Best Practices Program (WBPP) to transform their Water and Wastewater Services Division into a competitive public business. The goal of the WBPP is to re-examine existing functions and operations and to identify and implement "best practices" that improve the delivery of services as a business-driven, public utility. A focus on performance assures that these practices are measured and continuously improved.

A system to measure and manage the performance of the utility is integral to the program's long-term success. The system, called POMS (Performance and Operations Management System), was designed based on performance measures used to drive the reengineering of work practices and workforce roles and responsibilities. "Performance centers" were defined for team-based work areas with given sets of performance measures and targets. POMS can be viewed at the operations level to analyze plant process performance and at a management level to track overall performance trends. These performance center "dashboards" give utility managers and operators the tools for ongoing continued performance improvement.

Historical Perspective: A Shift in Emphasis to Performance

In the recent past, most wastewater utilities have been largely driven by government regulations and plant reliability considerations. With the watchwords of "no violations" and "no plant failures" little attention was given to cost efficiency or service effectiveness. Excess plant capacity, significant equipment redundancy, generous use of chemicals and energy, and on-shift reserve staffing levels, were all part of most utilities' strategies to guarantee service reliability and effluent quality. Little attention was given to cost of operation and maintenance (O&M) as long as it was within range for typical utility rate increases, with O&M usually overshadowed by capital cost increases. It's no longer true.

Yesterday's operating strategies are no longer good enough. Today's forces still include increasing government regulations, but O&M costs are usually the major consideration due to competition from private contract operators. "Getting competitive" means reducing these O&M costs while maintaining or even improving effluent quality and service reliability. The challenge most utilities face today is how to make the changes required to become competitive. New ways of working, new behaviors and skills, and new tools and technology are all needed for the massive transformation required by most utilities. Many times utility O&M costs must be reduced by over 30% to get to competitive levels. A focus on performance and performance measurement must go hand-in-hand with the focus on O&M cost reductions to avoid sacrificing service reliability and quality.

Utilities need ways of making these significant changes and continuously improving their performance to get and stay competitive. Tools are needed to analyze performance over time to achieve greater O&M efficiencies, and to predict when action or intervention is necessary to maintain service reliability or quality. Typical tools such as process control systems or SCADA (Supervisory Control and Data Acquisition) systems have limited analysis capability because these tools were not built for performance analysis and much of the necessary information (labor, energy, chemicals, and material costs and quantity) is not typically available. A different view of performance information is required which aggregates, consolidates and calculates meaningful measures for plant operators and managers. A performance measurement system must be carefully designed and built to present the right information to aid in achieving O&M efficiencies.

Well-designed and properly implemented performance measurement systems can enable utilities to achieve these new levels of performance. These information systems are typically enterprise-wide, meaning they must integrate measures from several “front-end” information and control systems. Performance measures are many times consolidated, aggregate measures, which combine costs and production information to enable near real-time adjustments in utility business processes. The needs for this performance information range from on the ground facility operation and maintenance to utility management, customers, and governing bodies. Using these measures for immediate feedback to make tactical decisions as well as later analysis for business process improvements is key for continued competitive performance.

Defining Appropriate Performance Measures Takes Time and Effort

In Toronto, performance measures were used to drive the reengineering of work practices and design of technology and organizational changes. As shown in Figure 1, effective performance measurement enables an organization to establish a baseline for its current practices and set reengineering targets for change. In the future, these same measures can be used to continuously improve or optimize the individual work areas, treatment plants as a whole, and the entire division. As an example in Toronto, the Highland Creek Treatment Plant implemented work area based performance centers as part of the Best Practices Program. The staffing level has been reduced from 120 to 79 by the initial work area teams, with an expected future staffing of 55 employees through additional automation and continuous improvement.

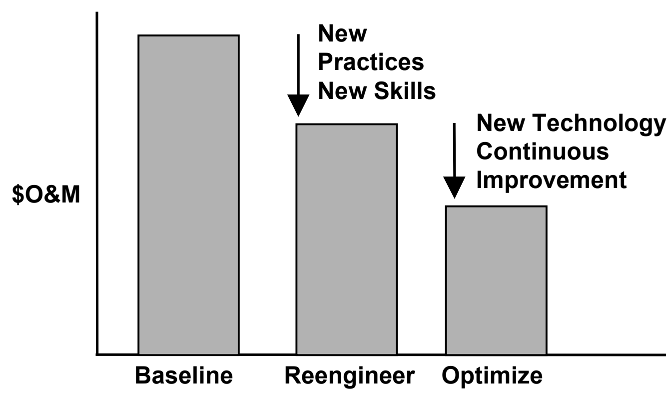

Figure 1. Performance Measures Can be Used to Drive Initial Changes as Well as Continuous Improvements

To accomplish these changes required defining the key measures, establishing today’s baseline, and setting improvement targets. During redesign of work practices and definition of the POMS, cross-functional, multi-facility teams were used to define these measures based on a performance framework and “balanced scorecard” approach. This framework allows for measures at various levels of the utility to provide different views of information for each performance center, such as those listed in Table 1.

Viewer of Performance	Performance Center Basis
Operator	Unit Process Level
Team Leader	Inter-Process Level
Plant Management	Plant/Facility Level
Division Management	Multi-Facility/Enterprise Level

Table 1. Performance Centers Provide Appropriate Views of Performance Information.

The balanced scorecard is based on measures of efficiency, quality, and effectiveness at each level of the performance framework. The types of measures for each level include:

1. Efficiency - measure of ratio of production (output) to the resources required (input), typically cost or time of input resources per unit of output (e.g. $/Ml treated).

2. Quality – measure of the characteristics of the output which adds value to a customer or stakeholder, often measured against a target value or compliance standard (e.g. effluent suspended solids, mg/l).

3. Effectiveness – measure of a process or service to meet demand or achieve outcomes, typically expressed as capacity effectiveness (relationship between demand and input, i.e. capacity available) or production effectiveness (relationship between demand and output, i.e. production results available.) Effectiveness is usually measured at a level above the process or service where related efficiency or quality is measured.

Each type of measure must be defined for each service or process at a given level, in order to have a "balanced scorecard". The challenge is to be selective in defining these measures to establish the smallest number of most relevant measures. An example of a set of measures using the performance framework is shown in Table 2.

	Performance Measurement		
Service or Process Level	**Efficiency**	**Quality**	**Effectiveness**
Plant Facility	Unit Cost to Treat ($/Ml)	Effluent BOD, Suspended Solids Total P (mg/l)	Treatment Capacity Available or Fish Kills
Solids Handling Process	Unit Cost to Treat/ Dispose ($/dry ton)	Aggregate Solids Cake Concentration (% Solids)	Process Unit Availability (% of Time Required) or Effluent Degradation
Sludge Conditioning for Dewatering	Polymer Dosage (kg/dry ton)	Solids Cake Concentration (% Solids)	Dosage Control Accuracy ***or*** Loss of Dewatering Capacity

Table 2. Performance Framework Shows Balance of Example Measures for Each Service Level or Process.

A key part of the process in implementing a performance "dashboard" for each level is first defining what to measure. However, just as important is the engagement of staff in this definition process and the shift in thinking required to use these measures in actual day-to-day operations.

Many performance measures have numerous parameters and calculations required to yield the end result of a single indicator. For example, a seemingly simple measurement such as unit cost of treatment (e.g. $/Ml) is really a complex aggregation of many measures which are typically sampled or recorded at various intervals with differing accuracy, timeliness, and availability. Therefore, to design and implement a workable and appropriate POMS requires analysis of the various components of the performance measure. Even at the unit process level, a performance measure such as unit cost to treat (e.g. $/Ml) is a complex aggregation of costs and production information.

Creating practical performance measures requires knowledge of the process and work practices to analyze:

1. What components of the measure have the most impact on cost or efficiency?

2. What components of the measure are most significant, i.e. what is the sensitivity of the measure to changes in each component?

3. What components of the measure are highly variable?

Analysis of the components for each performance measure is key to selecting and defining good measures. As shown in Figure 2, using POMS capabilities for trending (with control charts using statistical process control techniques) aids the selection of components for appropriate performance measures.

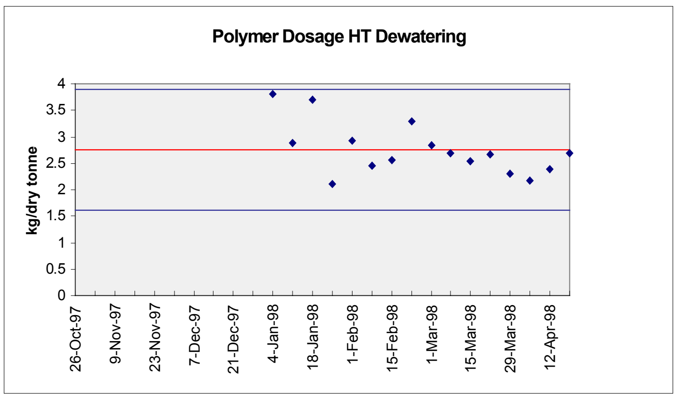

Figure 2. POMS Provides Control Charts for Analyzing Process Performance.

Performance Measurement Is Enabled with Integrated Technology

The Toronto Works Best Practices Program includes development and implementation of a number of systems to support changing work practices and optimizing business processes. POMS consolidates information from several "front-end" systems as shown in Figure 3. Each front-end system includes generic measurement capture to feed the "information broker" (middleware/software) which funnels data to POMS.

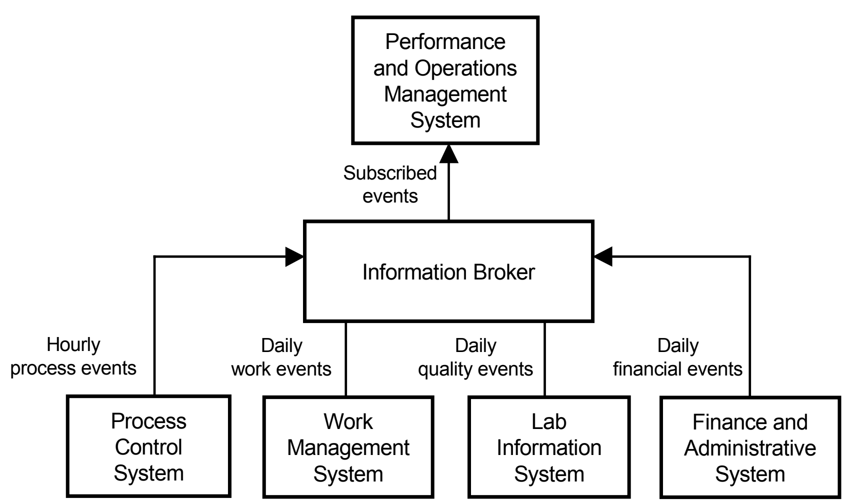

Figure 3. POMS Consolidates and Summarizes Performance Information from Several "Front-End" Systems.

As seen in Figure 3, a performance information system requires data transferred from a variety of systems including costs, quality, labor, and production information. Data must be rolled-up from real-time snapshot measures into hourly averages as well as captured from daily transactions. Many of the calculations to derive the performance measures become complex. POMS was built on an object database to provide flexibility and performance in using the system to “drill down” to measurement details wherever necessary.

The availability and use of these kinds of tools and technology are rapidly increasing, especially given today’s competitive drivers. Previously, these systems were either not technically feasible, or not warranted for lack of emphasis on performance. In the future, these kinds of performance management systems will be essential to stay competitive.

Examples Show Performance Information is Key to Operation Efficiency

Recent experiences show that even the initial implementation of POMS at the Highland Creek Treatment Plan has provided benefit to operations. This example can be contrasted with earlier operational changes at other treatment facilities where performance measures were not available, and operating inefficiencies went undetected for some time.

The earlier example involved changes in the control strategy for the sludge level in the digesters at a major treatment facility. The level control was changed because of instrumentation difficulties. As an unintended and undetected result, sludge was inadvertently returned to the aeration basins, which not only added additional load for aeration but also additional air supply, pumping, and heating costs. With no overall performance information available, these additional costs went undetected as the plant was still meeting its major compliance parameter limit.

A recent example at Highland Creek shows that performance measures can quickly show the impact of operational changes. When an incinerator was taken down for three days for maintenance, raw sludge was stockpiled, resulting in decreased calorific value, and reduced process effectiveness. The aged sludge required significantly more in chemical to dewater it and more gas to burn it. Operators could see the impact of their decision on overall unit cost, quality and throughput. The immediate decision was to divert additional resources for future incinerator maintenance to limit down time to one day.

Implementation of Performance Management Requires New Thinking

The combination of changes in operations and maintenance practices and the performance management system technology are both required to achieve new performance targets. Work area teams must be oriented to performance measurement and statistical process control concepts. This new thinking enables the technology to be used to attain the improvement targets and continuously strive to meet new levels of performance.