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# Getting Lean and Efficient

COMPUTER-AIDED MANAGEMENT

By Roger Anderson

Albert Boulanger

John Johnson

Arthur Kressner



*Continuously measuring and optimizing* a business process by enforcing cause-to-effect feedback loops is what Computer-Aided Lean Management software is all about. This operational innovation is a methodology for efficient enforcement of process rigor and discipline to dramatically cut costs and improve operations by removing “white space” or idle time within an enterprise, and cutting costs as well. Using CALM software also reduces operating risk, enhances customer service and reliability, and increases the assurance that each new improvement introduced to the process will be effective.

The software works by first mapping out the “as is” state-of-work processes of the organization. This is to develop a quantitative understanding of activities, resources, operational demands, and uncertainties that affect the business such as weather, equipment failures, and workflow processes in the field. In other words, costs, time spent, resources over and under expended, and historical data such as failure records, autopsies, and load response must be understood before the system can be taken to what we call the “to be” state of improvement that CALM represents. At Con Edison, we are using computational machine learning to develop what we call a “brutally empirical” view of the New York City electric grid.

Once the system’s nonlinear response to exogenous drivers is understood – even in a rudimentary form – CALM requires an integrated system model to determine policies and actions to begin the improvement process that will optimize system performance:

- » *A high-resolution*, integrated electric model of the entire system, from generation, through transmission and distribution, to all customers must be constructed.
- » *The business process model* must capture detailed processes of the company’s workflow to track and measure performance on a daily basis.

- » *The machine learning system* must then be connected to the electrical and business process models so that diagnostic analyses of historical and operational data captured in existing databases can be used to simulate improved processes.
- » *Then a dynamic scheduler* must be added to optimize the field operations that are continuously affected by the uncertainties of weather, equipment failure, and changing customer consumption patterns. The driver of work processes must be able to immediately respond with optimal changes in schedule.

Put this all together and you have CALM’s Integrated System Model (ISM) that allows for hundreds of scenarios to be run in the computer before any scheduling and work process changes are actually implemented.

## Utilities Similar to Lean Industry

There are many similarities between electric utilities and successful lean companies such as automotive leader Toyota and aerospace giants such as Boeing and Lockheed Martin. All require large-scale systems integration of complex engineering processes. They involve multiple suppliers that are global, and each owner shares many common suppliers. Lean management provides for earlier engagement of integrated development teams, improved access to new technologies, definitive “go/no-go” decisions, and an enhanced resource base and skill level for its managers and engineers. Lean management lowers costs through more commonality in supply, compressed cycle times, capital and maintenance projects that are on time and on budget. However, it takes several years to fully implement the lean methodology.





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Consider the complex process of scheduling replacement, repair and improvements to the electric grid while at the same time dealing with emergency outages caused by equipment failures and unforeseen weather contingencies. Con Edison has mapped the “as is” scheduling process and has found opportunity for improved performance.

CALM minimizes the crossing of business units by creating cross-functional teams to identify white space and minimize costs through process improvement. Unlike attempts to re-engineer processes popular in the literature or with consulting companies, CALM tightly integrates lean software tools for appraisal, planning, construction, operations, all the way to the field work, with lean processes in the organization for planning, scheduling, supervisory control, regulation, management, security, and environmental impact. Included are major cost reductions and operability gains from enhanced project visibility and transparency, increased innovation, and the sharing of knowledge and understanding throughout the enterprise.

CALM processes eliminate waste and miscommunication, while requiring seamless information flow. However, this change requires major redefinition of information technology departments, in particular. No longer is “ownership” of data or computer processes confined to the IT department; instead, CALM distributes it outward to the locations of the workflow itself.

### Charting Progress

How can the electricity industry effectively evaluate the risks associated with conversion to CALM processes and tools? Accurate metrics of savings must be gathered and continually analyzed. Savings can be expected from shortened crew time caused by the elimination of

waiting time in the field and from precise delivery of materiel, but additional savings can come from more subtle metrics:

- Reduced field work instruction ambiguity
- Faster reviews of options
- Earlier scheduling decisions
- Higher levels of work quality
- Better supplier collaboration
- Improved visibility of the total project
- Improved change-order management
- Reduced site queries
- Better health, safety, and environmental impact assessments
- Improved interfaces with contractors
- Dramatic turn-rate and other supply chain improvements

CALM seeks to constantly integrate tasks in order to implement system-wide solutions. This requires a seamless digital environment that is essential in today’s business world. However, stakeholders must work together before the required cost and cycle-time savings from this software innovation can be fully realized.

*Roger Anderson is Doherty Senior Scholar at the Center for Computational Learning Systems (CCLS) and Lamont-Doherty Earth Observatory at Columbia University. Albert Boulanger is senior scientist at CCLS and Lamont-Doherty. John Johnson is program manager of CALM in the strategic planning department at Consolidated Edison. Arthur Kressner is director, power supply research and development at Consolidated Edison.*

# Dealing With Transformers

By Jack McCall

*Proper asset management* of power transformers allows utilities to mitigate risk, effectively manage capital and deliver reliable power.

Decades of both long-term expansion of the power system and low transformer failures finds the industry in the situation where many utilities continue to operate transformers that have exceeded standard life expectancy. Several utilities have reported that more than 40 percent of their substation transformer population is more than 40 years old. Consequently, insurance companies have recently predicted an increasing frequency of transformer failures.

According to the Federal Energy Regulatory Commission, there are more than 132,000 medium and large power transformers

currently in service. Considering the North American production capacity is approximately 1,000 medium and large power transformers per year, it is clear that maximizing the useful life of transformers already in service is an important goal for utilities.

To address these aging concerns, utilities are looking to an edible-seed oil-based, environmentally friendly, high-fire point transformer fluid that can be used in place of traditional, petroleum-based mineral oil. When used to retrofill existing transformers, the fluid has been proven to successfully address two key concerns – public safety and environmental risks.

By using an edible seed-oil fluid, the number of fires associated with failed transformers also decreases. Industry research

shows that one in five failed substation transformers using petroleum-based mineral oil results in a fire and financial losses are inevitable. In 2004, a fire in a transformer at a utility in Arizona destroyed four adjacent transformers, costing the utility millions of dollars in clean-up and repairs.

Asset management can take many forms. For power transformers, it includes taking simple steps that prolong transformer life, reduce potential damage due to fire and improve public and environmental safety.

*Jack McCall is North America marketing director, Cooper Power Systems, based in Pewaukee, Wis.*

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# Go Mobile

By ~~David~~ Owen Causey



Everyone knows that utilities are asset-intensive businesses and that those assets are geographically distributed over wide areas. Utilities employ large, expensive workforces to install, maintain and repair those assets. Therefore, it seems logical that asset tracking, replenishment, repair, maintenance and installation should be very field oriented.

And yet the historic pattern of software development has approached this reality from directions that sometimes defy logic. For example, the earliest enterprise resource planning, supply chain and enterprise asset management software systems were entirely desk-bound. Utilities found themselves with highly complex software systems that could track warehouses full of parts and supplies, account for them financially and replenish them through online communications with their suppliers. But communications with the field, where the assets are stored, located and expended, still was handled mostly by paper orders delivered by having dispatchers read them over radios.

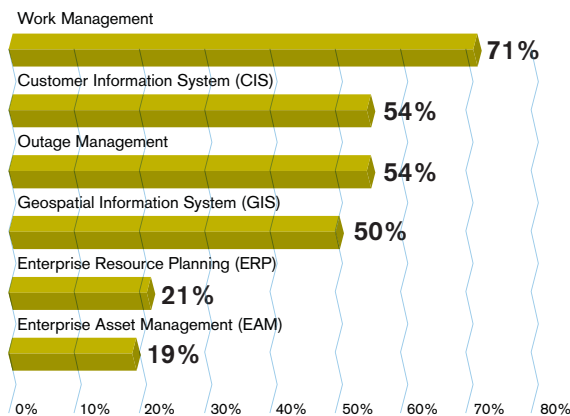
Even today, most utilities do not have ERP/EAM access from the field. Those utilities with mobile systems, which are still only about 50 percent of large investor-owned utilities and more like one-third of smaller co-ops and municipals, still rely on complex office-based interfaces to update asset information. Only between about 20 percent of utilities have mobile access to ERP/EAM.

A major part of this problem is the result of how business automation has developed and was driven during the 1980s and 1990s. Vendors and in-house developers who came up with a new idea and then attempted to sell it drove software/hardware innovations. Such ideas generally addressed one specific business need and ignored other related problems/issues. Thus, only today, enterprise computing is becoming a widespread mantra. But it is one that utilities now are demanding. And vendors are rushing to try to fill the gaps between the stand-alone systems. It seems that pushing asset management to the field—where it's actually done—is finally catching on.

Virtually all major asset management vendors now are adding mobile capabilities to their systems, as the following examples reflect:

- » *IBM is building* out mobile capability under its WebSphere initiative, calling it DB2 Everywhere.
- » *SAP is adding* mobile links through its Netweaver SOA system.
- » *Indus now offers* mobile through its Service Delivery Management system.
- » *SPL Worldgroup now offers* Mobile Workforce Management to link back to its Enterprise Asset and Work Management system.

## Utilities Systems With Mobile Access



Source: Sierra Energy Group

Eventually when a lineman approaches a pole, his vehicle will be loaded with exactly the correct parts for the job at hand because the asset management system has pushed them to his truck. When he does the work, his wireless device will update the ERP/EAM so the replacement parts are accounted for and ordered automatically. His wireless device also will update the facilities map, with the changes being reflected back through to the GIS, where he or anyone else can click on the pole and see the changed part numbers and configuration, and other pertinent changes. The expenditure of time and equipment will be automatically updated on the financial and ordering system, and the costs will be rolled up to an executive dashboard, where anyone who needs the information can see it. Then the field worker's device will direct him to the next location with GPS tracking his progress and location.

It hasn't happened yet, but with asset management vendors finally adding mobile capabilities, that future may not be too far off.



## Xcel Energy-Distribution Asset Analysis

# Identifying/Forecasting Energy Load Increases Accuracy, Customer Satisfaction

In the summer of 2003, Xcel Energy, based in Minneapolis, Minn., experienced an increase in distribution transformer failures in its Colorado service territory. Hot summers, new subdivisions, and retrofitting of older homes with new heating and cooling systems all took their toll. Utility officials searched for solutions to identify heavy growth loads and underutilized areas, increase reliability and keep customer satisfaction a top priority.

## AN OPPORTUNITY FOR IMPROVEMENT

Xcel focused on identifying load growth in the system in order to respond before demand overwhelmed the infrastructure. They needed precise customer load data-information to identify those assets that should be replaced before they failed, and under-utilized transformers. In addition, the utility wanted to reduce outage duration and frequency in metro areas.

"Energy data is the bloodline of a distribution utility," said Lynn Worrell, manager of electric capacity planning at Xcel. "Distribution costs are generally the highest expense for most utilities and the demand placed on distribution assets is steadily growing at a sometimes taxing rate. We need accurate tracking of outages with rapid response and remediation."

The utility already had the data sources required to model electrical utilization and loading at a very granular level. However, they lacked a tool to bring the data together and complete the complex calculations, analysis and reporting.

"Load growth at Xcel Energy has been rapid and has challenged our distribution infrastructure," said Worrell. "We needed a tool to help us identify asset loading which would also help us prioritize our investment dollars."

## A TOOL FOR PRECISION FROM ITRON

In September, 2002, Xcel decided to implement the Distribution Asset Analysis (DAA) software solution from Itron. DAA identified load patterns and asset utilization for each circuit and distribution transformer. Using historical billing and meter data, weather patterns, and proprietary analytics, DAA provides year-round, hourly load profiles for all transformers and related assets associated with the 1,850 circuits identified in Colorado, Minnesota, North Dakota, South Dakota and Wisconsin. This represents more than 460,000 transformers, serving about 3.5 million customers.

DAA allows Xcel to identify those circuits and transformers that are at risk for overloading or under-loading, as well as a pro-active replacement program, saving money and increasing customer satisfaction.

DAA provides a precise engineering methodology of predicting circuit and transformer loading. In cooperation with IBM Global Services, Itron receives data daily from 11 of Xcel Energy's existing customer and operating systems. DAA automatically filters and corrects any missing or incorrect SCADA or customer data, creating an accurate database of customer, device, and SCADA information.

"Through the use of DAA, we have discovered overload conditions in our system that would have otherwise gone undetected until a failure occurred," Worrell said.

## RESULTS

In one of its first deliverables to Xcel, Itron identified 300 transformers that were likely to fail based upon loading and weather modeling. Xcel used this information to help target transformer replacement in May of 2003, just before the beginning of a hot summer season.

According to Xcel, the summer of 2003 saw a 5 percent reduction in outage-related complaints after DAA was implemented. Multiple interruption and long duration outages declined by 25 percent through efforts to quickly replace transformers after the first outage.

Since the summer of 2003, indicators have been refined by learning from the results from previous years. Xcel now factors in peak load growth and peak hot spot temperature changes from previous years. As a result, 600 transformers were proactively replaced in 2004 and 206 in 2005.

Xcel also uses sub-feeder device loading produced by DAA to improve service reliability by correcting overloaded switches and fuses, balancing loads, and investigating causes of outages downstream of the feeder breaker. Since 2004, over 200 work orders were created to proactively alleviate overloaded taps. This information was not readily available prior to DAA.

"We expect our reliability to improve since we now have more information about system loading on our feeders, taps and service transformers," said Worrell. "Ultimately, the customer wins with more accurate, reliable information."

Itron continues to work with Xcel today, fine-tuning its DAA solutions and working as part of a unique team called Utility Innovations. Utility Innovations is a proof-of-concept project, leveraging the research and development investments of strategic partners to develop innovative products that will change the way utility customers are served. Through the integration of existing technologies and the creation of new technology, the Utility Innovations team is working outside the realm of what they know and developing the art of what is possible. By leveraging technological advances and incorporating innovative ideas from employees, the team is developing new and creative solutions to better serve our customers.







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**Releasing your potential**

# Cut Costs

By Tage Blomberg

*It makes economical sense* to enable power plant owners and operators to get the most out of their investments. Developing lifecycle support solutions and establishing long-term relationships allow for sound business and technical benefits.

The future of power generation is, and will be, more about the business of power. An asset's costs and returns will be more in the management's thinking and decisions. Investments will be considered in the short- and long-term perspective. The power industry is already seeing a heavy swing towards the life extension and modernization of an asset rather than the energy companies entering into expensive and long-term investments for new greenfield projects.

Plant services such as outsourced operations and maintenance contracts that save time, effort and money for the plant will become even more important factors in asset management thinking, planning and investment. The effective running-of-power asset, which provides them with the best lifecycle costs, is the primary goal for many of our customers.

Typically, the running cost of a power plant is affected by the technical solution and systems employed, size and location. For the owner/operator, many of these costs are difficult — if not impossible — to predict, making asset costing forecasts a hazardous task. A typical cost distribution usually comprises O&M costs at 12 percent, fuel at 50 percent minimum, repayment and interest of loans at 30 percent and other costs at 8 percent.

As new technologies are introduced for power plant operations, it is essential for the plant's management to optimize these technical solutions to ensure their asset continues to perform at the highest efficiencies possible. Here, environmental aspects are an important consideration, especially the need to obtain accurate information on vital energy production parameters to keep the plant within environmental limits. A plant may also need several revitalizing packages to perform optimally throughout its lifetime. These upgrades would be recommended and implemented by the O&M contractor, thus ensuring the plant continues to be a valuable asset.

The energy market of today has moved from the traditional, big centralized solutions of yesterday towards a more decentralized energy production, often resulting in low manned or even unmanned plant operations.

Utilities in developing countries are showing more interest in establishing cooperation with O&M providers to operate and maintain power plants. Environmental and efficiency requirements and burning new fuels like bottom oils, emulsified fuels and bio-oils have forced manufacturers to increase automation levels and complexity of installations to a degree that experts are needed to operate and maintain the installations.

Asset management is a business tool for achieving efficient operations.

*Tage Blomberg is Wärtsilä group vice president of service, based in Helsinki.*

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