Optimizing Deployment of Next Generation Maintenance Strategies
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What is Asset Health?

For the purpose of this research and the scope of this study, The McDonnell Group suggests a summary definition of asset health to encompass the following:

- **Asset health provides comprehensive, real-time, automated equipment failure risk assessment along with the data, output and tools to support cost justification for complex O&M decisions and to ensure regulatory compliance.**

- **Asset Health combines asset management, network management, business intelligence, communications and automation, driving value for utilities by bridging current divisions between IT-centric and engineering-centric operations (OT) functions and solutions.**

- **Asset Health is not a ‘product’ or ‘solution’ for any particular area. It represents a holistic approach that encompasses a vision for the future of utility asset optimization through effective maintenance and operations.**
Executive Summary

Asset Health: The Current State and Future Strategy of North America’s Top 100 Utilities

Ensuring the reliability of aging assets is not just a top priority for utilities—it is also a regulatory mandate. Siloed data reduces productivity and contributes to difficulties in meeting this mandate. It also represents one aspect of an even larger problem: the cultural and organizational divisions between information technology (IT) and operations technology (OT) (see box on right). Asset health addresses the need for better IT/OT integration, a need that the utilities interviewed for this study have either begun to address, or consider a top priority for the next two or three years.

Utility executives and O&M managers typically have a good picture of what their ideal systems might look like if they had the ability to build an entirely new T&D infrastructure from scratch. They recognize, however, that it is a different matter to achieve their ideal system from where they are today, because the system of the future has to be justified and built as part of the process of operating and maintaining the system they currently have in place.

Asset Health for Substation O&M: The Complexity of Utilities’ Current Environment

The focus of this research study was O&M for substations with voltages greater than 34kV in the top 100 utilities in North America. The key decision makers interviewed in this study own and operate large fleets of substations this size. Decision makers indicated they have historically used a complex mix of maintenance management strategies to ensure that their O&M processes uphold reliability and compliance standards, while addressing numerous challenges; most notable of which are aging assets, increasing costs and budgetary constraints.

Sample & Methodology Overview

The research began in Q1 2011 and consisted of interviews with 23 North American utilities regarding substation asset management, operations and maintenance. These interviews were drawn from a target sample of the top 100 North American utilities ranked by substation assets in this class. The McDonnell Group conducted scheduled interviews averaging 30 minutes with 34 decision makers at these utilities. Decision-
makers in this area included VPs, Corporate Management, Directors, Corporate IT, Managers in Transmission/Distribution, and Reliability/Regulatory Compliance groups.

While this study is not statistically representative of the entire global utility industry, the investor-owned utilities interviewed in the study were among the largest of the 141 such IOUs operating substations 34kV and higher in the United States. According to the FERC Form 1 data employed to select candidates for the study, those interviewed for this study own 31% of the total number of substations in the country, and 27% based on the overall installed capacity (MVA).

Aside from these American IOUs, the study also included large Canadian utilities and several American state, federal, and cooperative utilities with substantial substation assets. Participants consisted of 64% IOUs and 36% non-IOUs.

**Description of the Asset Health Concept**

For some perspective on the overall context of the survey, note that prior to the last section of questions in each interview, The McDonnell Group’s research interviewer presented the following description of the substation asset health concept to study participants to gauge their reaction:

*When looking at industry trends, the combination of technology advances (e.g. sensors, data communication, computing power, storage, etc...) coupled with substantial decreases in the cost of this technology seems to point to a more viable and cost effective implementation of online monitoring of distributed assets which would allow your company to:*

1. Have a way to collect information from many different sources, to clearly identify which substation assets have a higher risk and consequence of failure, and to communicate details of this risk, so decision-makers can figure out the most effective action(s) to reduce that risk;
2. Have a clear view of asset conditions that will support optimal maintenance decisions, and lead to better controlled and more predictable operations and maintenance spending;
3. Drive the adoption of uniform and effective processes across the whole company for maintenance and asset replacement strategies.

Throughout the research, there were diverse and strong indications that the majority of utilities embrace this concept, with leading utilities moving in the direction of the asset health vision today.

**Summary of Research Results**

- The majority (53%) of all respondents ranks ensuring reliability of their aging assets as the top strategic priority for their company as a whole, and 94% considered it one of their company’s top three priorities.
- Regarding substation O&M and asset management practices for substations 34kV and up, 35% rank compliance management as the top priority for the next 2-3 years, driven by concerns about fines imposed by regulators.
In addition, 74% considered increasing costs of maintaining aging substation assets as one of their three priorities to also address in the next 2-3 years.

Less than a third (29%) of participants feel that the current level of IT/OT integration at their company is either excellent (12%) or very good (17%).

Remaining participants unanimously agree that achieving a higher level of IT/OT integration in the next 2-3 years is important, with an impressive 83% stating it is either very important or critical.

Utilities that have started implementing the vision report a higher level of receptivity to making additional investments on asset health, an indication that they see the benefits.

Getting From Here to There—a Targeted Approach

Fully 76% of the utilities surveyed said they have current or upcoming initiatives to improve their O&M and asset management practices for their high voltage substations. Some of these involve ongoing process improvements instead of more fundamental changes, while many are in the early assessment stages, versus full deployment or implementation.

A common approach people described regarding these initiatives involved focusing on critical assets. The following quotes represent this:

- “We will target specific infrastructure first, and look at our O&M maintenance trends to see what has value and what does not”
- “Maintenance dollars are not increasing, experience level is getting lower, and the only way we can continue to keep the system afloat is to have better information and evaluate and analyze more it thoroughly, enabling us to target the resources we have now”
Research Methodology & Sample

The McDonnell Group, Inc. recruited executive survey participants and completed telephone interviews for the study during March and April of 2011. While the list of companies participating in the study is confidential, the sample includes:

- 5 of the top 10 US investor owned utilities by number and installed capacity of substations 34kV and up;
- 4 representative utilities from the cooperative, state, and federal sectors;
- 2 Canadian provincial utilities.

Job functions represented in the sample range from engineering decision makers as well as corporate management and break down into the percentages below.

<table>
<thead>
<tr>
<th>Job Function</th>
<th>Percentage</th>
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<tbody>
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<td>1. Corporate Management</td>
<td>23%</td>
</tr>
<tr>
<td>2. Transmission Operations **</td>
<td>42%</td>
</tr>
<tr>
<td>3. Distribution Operations **</td>
<td>17%</td>
</tr>
<tr>
<td>4. Reliability / Regulatory / Compliance role with Substation focus</td>
<td>13%</td>
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<tr>
<td>5. Corporate IT</td>
<td>6%</td>
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**Including construction, engineering planning, maintenance, operations, metering**

Selected Sample Titles of Study Participants

- Manager Substation Operations
- Manager, Substation Relay, Communication, and Maintenance
- Operations Manager
- Operations Manager
- Project Manager IT
- Senior Consultant Engineer
- Substation Superintendent
- Superintendent of Technical Operations
- Transmission Construction Manager
- Vice President Supply Chain
- VP Delivery
- VP Distribution
Top Substation O&M Priorities

When asked what they feel is the top priority to address in the next 2-3 years for their substation O&M and asset management practices for high voltage substations, the most popular choice is compliance management. Utilities mention the need to meet NERC, FERC and CIPs standards, as well as the necessity to avoid severe fines that can be leveled by regulators for not meeting reliability and security standards.

Respondents included in their top three choices the need to address the increase in cost of maintaining aging assets (74%), and included available capital for replacing aging assets (71%).

In this regard, a repeated observation expressed by IOUs is that it is easier to make new capital expenditures than to get additional funding from their regulators for repair/replacement of aging assets. This is especially problematic in the case of assets that are not fully depreciated but need to be replaced.

Since asset health facilitates better targeting of repair/replace decisions, it can help address this issue, both in the aggregate, by enabling operators to stay within annual budgets for overall repair/replace expenditures, and also in specific instances by
providing the data and tools for more detailed cost justifications. Asset health will facilitate a high-level re-examination of the financial and operational benefits of increases in such expenditures going forward.
Predominant Forms of Maintenance Management

Responding utilities use a range of maintenance management strategies for substation assets. When asked to identify the most typical or widespread maintenance management approach they were using, 91% selected either time-based maintenance (35%), maintenance based on equipment loading/number of operations (27%), or predictive methods (29%). Only 9% identified “fix it when it breaks” (6%) or “using online sensors” (3%) as their most widespread form of maintenance management.

Although there may be fundamental differences between these groups of utilities in their maintenance management strategies to meet reliability goals, this bell curve reflects the impact of operational variations—first in each utility’s installed base of assets, and second in differences in regulatory and financial drivers. These variations, over time, yield this natural distribution as a mix of the “classic” maintenance management strategies, since the operating environment shapes the philosophy and its implementation.

In general, researchers found IOUs to be more ‘advanced’ in their predominant form of maintenance, with nearly three quarters (73%) currently performing maintenance
based on loading or number of operations and over a third (37%) employing predictive maintenance.

The majority of non-IOUs (67%) report using time-based maintenance.

**The need to improve IT/OT Management**

Researchers asked utility decision makers to consider the difference between “engineering-centric” and “IT-centric” functions to assess the current level of cultural integration between these functions at their organizations. Researchers defined cultural integration as the alignment toward the same business objectives, as well as business process integration between the two functions.

The 71% who did not choose ‘excellent’ or ‘very good’ were asked as the follow-on question, “how high of a priority in the next 2-3 years is your substation O&O achieving a higher level of this integration.” Universally it was at least ranked important, with 83% ranking it very important or critical. No respondents selected either of the two lower-priority choices of not ‘very important’ or ‘not important at all.’
Quantifying the Risk of Failure of Substation Assets

When asked about the best way to quantify the risk of substation asset failure, with options being statistical analysis, engineering algorithms and an engineer’s review and judgment, half of the participants said that it required a combination of all three. To be clear, this was not originally a suggested response on the researcher’s instrument, but the continued request by participants warranted its inclusion in the report.

The popularity of a combination approach is another indicator of the importance of integrating IT and OT functions. As shown below, there is strong recognition that OT capabilities involving engineering judgment need to be employed in parallel with IT-centric statistical and other analytical techniques.

What do you think is the best way to quantify the risk of failure of substation assets?

- Combination of all 50%
- Statistical analysis 9%
- Engineering algorithm 29%
- Engineer review & judgment 12%

N=34
Situational Awareness Tools to Transform Data Into Needed Inputs for Engineering Analysis

When asked about initiatives to improve asset management practice, 71% of participants felt that tools for supporting better operational decision-making through improved situational awareness were very important or important. This provides another instance of the salience of combining IT and OT centric technologies to enable practical, real-time business process improvements.

Please rate how critical you think the following initiatives are to improving your current substation O&M and asset management practices for your high voltage substations in the next 2-3 years?

(*) Interestingly, those self assessing as on the leading edge/among early adopters find ‘more extensive deployment of sensors’ significantly more important than those who feel they are in the majority (85% vs 48%)
Asset Health Conclusions: Taking the Pulse and Meeting the Challenges

Our research indicates that the concept of asset health aligns with the current direction of leading utilities and the vision of the future shared by the industry as a whole. Utility maintenance management practices are on a clear continuum. Going forward, there will be greater recognition of a full infrastructure to support the value of deeper deployment of sensors for real-time monitoring of critical assets.

The infrastructure to support this inexorable push of real-time data to improve both the quality of decision-making as well as overall productivity has to involve a greater and more profound IT/OT integration.

Our research shows that there is universal recognition that IT is fundamentally a driver for engineering-centric OT functions, rather than the other way around.

The challenges involved in successfully implementing asset health fall into two broad categories: general industry challenges, and utility-specific challenges.

General challenges include:

- Meeting standards (communications, security) and minimizing related obsolescence risks
- Addressing numerous interoperability requirements
- Ensuring the ability to get the needed data with higher levels of reliability than the assets themselves
- Providing the tools so that the data and system support real-world decisions

Utility-specific challenges include:

- Ensuring modularity of the solution, to allow for many different implementation pathways that minimize potential for stranded IT/OT assets
- The ability to provide cost justifications to meet regulatory and financial hurdles
- Having a targeted approach to match each utility’s maintenance strategy profile to the right elements of the total asset health solution mix

It will be vital for each utility to identify their position on the continuum of maintenance strategy evolution, both in reality as well as in executive vision. Asset health holds the promise of great benefits for each utility, but realizing the benefits will require different pathways for different utilities. This vision is so specific that it will require utility-specific ROI tools and analysis to help justify optimal implementation planning.
Additionally, there has been increasing discussion about the “brain drain” and the need to use IT to archive and codify specific knowledge about equipment and day-to-day operational issues lost as experienced workers retire. The economic downturn of the past few years may have slightly mitigated this trend temporarily, as some individuals who would otherwise have retired ended up extending their careers due to financial considerations. In contrast, as the economy picks back up there could very well be an acceleration of the “brain drain.”

Acknowledging this, one respondent is quoted as saying,

“Obviously we have an aging workforce and it is harder to get people in and trained. Knowledge is walking out the door. It’s good to have a vision of data collection and sensors so that in the future, when we may not have the expertise, we have a system to back us up. We have to look to the future to find ways to maintain assets with fewer people.”

During the interviews, the researchers recognized that many of the participants are those who will soon be walking out the door. These people are a great resource for the implementation of the asset health vision, especially given the depth of variation in each utility’s maintenance management and operational challenges uncovered in the research.
About ABB

ABB is a leader in power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact. The ABB Group of companies operates in around 100 countries and employs about 124,000 people.

ABB’s businesses consist of:

**Power Products**
Power Products are the key components to transmit and distribute electricity. The division incorporates ABB’s manufacturing network for transformers, switchgear, circuit breakers, cables and associated equipment. It also offers all the services needed to ensure products’ performance and extend their lifespan.

**Power Systems**
Power Systems offers turnkey systems and services for power transmission and distribution grids, and for power plants. Substations and substation automation systems are key areas. Additional highlights include flexible alternating current transmission systems (FACTS), high-voltage direct current (HVDC) systems and network management systems. In power generation, Power Systems offers the instrumentation, control and electrification of power plants.

**Discrete Automation and Motion**
This division provides products, solutions and related services that increase industrial productivity and energy efficiency. Its motors, generators, drives, programmable logic controllers (PLCs), power electronics and robotics provide power, motion and control for a wide range of automation applications. The leading position in wind generators and a growing offering in solar complement the industrial focus, leveraging joint technology, channels and operations platforms.

**Low Voltage Products**
The Low Voltage Products division manufactures low-voltage circuit breakers, switches, control products, wiring accessories, enclosures and cable systems to protect people, installations and electronic equipment from electrical overload. The division further makes KNX systems that integrate and automate a building’s electrical installations, ventilation systems, and security and data communication networks.

**Process Automation**
The main focus of this ABB business is to provide customers with products and solutions for instrumentation, automation and optimization of industrial processes. The industries served include oil and gas, power, chemicals and pharmaceuticals, pulp and paper, metals and minerals, marine and turbo charging. Key customer benefits include improved asset productivity and energy savings.

**Ventyx/ABB**
Ventyx/ABB is the software arm of ABB, and provides business solutions to global energy, utility, communications and other asset-intensive organizations. Ventyx/ABB personnel solve complex technical challenges with innovative solutions and deep industry-specific domain expertise.
About Ventyx an ABB Company

Ventyx an ABB Company offers a broad range of solutions to address customer’s most critical needs, including:

- Asset and Plant Management
- Mobile Workforce Management
- Energy Portfolio Management
- Customer care

Ventyx an ABB Company improves customers’ operational and financial performance with innovative applications of technology and expertise. In nuclear plants improving safety, compliance and uptime, in field workforce organizations automating mobile work and optimizing productivity, in corporate offices supporting long term planning and forecasting of multi-billion dollar resource investments, and in trading floors processing the purchase and sale of electricity and fuels, Ventyx/ABB people and technologies are proven. In the energy mid-office reducing positional risk, in the call center responding to critical customer needs, and in the generation office optimizing tomorrow’s electricity production, Ventyx/ABB is proven.

- Ventyx/ABB holds a large market share in asset management software and services with more than 400,000 users in 59 countries around the globe.
- Ventyx/ABB holds a large market share in mobile workforce management in energy, utility, and communications markets with over 100,000 licensed mobile users worldwide.
- Ventyx/ABB holds the largest market share of worldwide energy analytics solutions users.
- 49 of the top 50 Fortune 1000 Energy companies, and 48 of the top 50 power generators in North America use a Ventyx/ABB solution.
- 9 of the top 10 European power generators and 4 of the top 5 European utilities use a Ventyx/ABB solution.
- 19 of the top 20 North American nuclear operators measured by highest capacity factor use a Ventyx/ABB solution.
- 15 of the top 20 North American gas utilities use a Ventyx/ABB solution.
- All 20 North American electric retailers and all top 20 North American coal consumers use a Ventyx/ABB solution.
- 124,000 miles of North American transmission lines, representing 27% of total miles, rely on a Ventyx/ABB solution for mobile work and asset management.

Today, Ventyx/ABB’s performance proven track record extends to the areas where customers face their greatest challenges—SmartGrid planning, deployment and commercial operations; Green energy programs to optimize renewable energy and carbon emissions; Improving asset safety and reliability; and Transforming field service management.
About The McDonnell Group

The McDonnell Group delivers a unique trilogy of energy and technology focused marketing services: Research, Strategy, and Public Relations. We provide expert insight and specialized knowledge—of the people, the trends, and the technologies unique to the utility and enterprise software markets. With our Focus on Practical Methods™, we work closely with your executive team to deliver strategy and advisory services, research-based marketing, and public relations to help you grow and guide your business in a way few can match. www.themcdonnellgroup.com