"Bottom Up" Asset Management: a Case Study

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Abstract

In order to become an Asset Management focused company it is important to utilize the strengths within your existing organization, as well as consultants, contractors and suppliers. A simplified definition of Asset Management is "the act of controlling in action or use, the total resources, intellectual and physical, within an organization".

This paper will illustrate a methodology described as "Bottom up Asset Management". The "Bottom up Asset Management" goal is to become more focused on your total core assets and define how each asset, including your human capital, can contribute to the long-term success of your company. A case study illustrating the value in applying a bottom up strategy through the utilization of the creativity and practical knowledge of front line employees of AltaLink Management Ltd. and the entrepreneurship of Cantega Technologies Inc. will be presented.

The first critical step in the application of an asset management style is to determine the scope of the asset management function. Concentrating on core assets and core competencies of employees across all disciplines is the best method. In order for staff to have a better understanding of how their intellectual capital contributes to the long-term success of an organization they must have an opportunity to view the organization with a wider focus. Another critical step in preparing to move to an Asset Management focused company is to list the core assets, then overlay core intellectual capital in order to identify gaps in your organization. The bottom up methodology enables the employees to understand more fully how they contribute to the success of the front line changes required to become more asset focused.

In the more commonly applied "top down approach" focus on process and physical assets results in organizations neglecting to utilize the intellectual capital embedded in their employees.

Introduction

The de-regulation of the electrical industry has brought great change over the past several years and there seems to be a trend for the majority of the utilities to adopt an "Asset Management" style in order to maximize diminishing resources both human and monetary. A good number of utilities applied a concept in the 1990's called "Reliability Centered Maintenance". Through RCM analysis they were able to determine with some degree of accuracy the probability and consequence of the failure of major components on their systems. The probability aspect is determined by the condition of the asset, which may be driven by age but not exclusively. RCM is a well disciplined logic that focuses on the preservation of function rather than assets, which by including the experience of maintenance personnel fosters employee participation in change. This is an important aspect of the RCM process as it included the front line staff in changing the way maintenance was performed.

The expected outcome of the RCM analysis was a maintenance program that addressed predominate failure modes with cost effective maintenance tasks. Utilities who have successfully implemented RCM can now leverage their experience gained through the inclusion of front line staff when moving to an Asset Management focused organization.

Bottom up Asset Management

It is important to understand the changes required in your organization in order to become an Asset Management focused company. The most common error is to believe that Asset Management should focus on profits and physical assets, when in fact it is the resources both physical and intellectual that enable "your organization to make money" that are important. In order for staff to have a better understanding of how their intellectual capital contributes to the long-term success of an organization they must have an opportunity to view the organization with a wider focus. A product of this exercise is an employee that more fully understands the concepts of Asset Management.

Strengths and weaknesses within the organization can either enhance or hinder the successful integration of Asset Management; these must be identified early in the process. The Asset Management goal is to become more focused on your total core assets and define how each asset within the company can contribute to your long-term success.

In addition to having a plan for where you want to get to, you need to identify where you have been. This will enable you to assess the effort required to move your culture from the existing focus to "an asset management focus". Typically a regulated utility was comprised of several highly skilled groups focused on their discipline, department or geographical area sometimes called "silos" or "stovepipes". Because both your physical and intellectual assets are distributed over a very large area it is critical as the silos are dismantled and the old vertically integrated organization disappears we rebuild a new structure focused on "assets" both physical and intellectual.

As organizations seek to increase productivity it becomes imperative they make better decisions on spending both operational and capital dollars. The goal of our Asset Management focus is to improve our knowledge of the condition of our assets in order to achieve a balance of risk, performance and cost.

Bottom up Management Concepts

- Implementation of an RCM analysis
- Structured implementation of a Root Cause Failure Analysis program
- Centralize maintenance planning groups of cross functional employees
- Implementation of new technology (monitoring systems)
- Improved data collection concerning condition and operational stress of core assets (transformers)
- Risk based maintenance and asset replacement decisions
- **Modification of design and or specifications based on asset performance**

The following case study will illustrate the value in examining failures and utilizing the experience and knowledge of front line staff in the redesign of assets in order to:

- Extend the life of the aging transformer fleet
- Increase reliability to customers
- Reduce environmental impact.

Case Study

The objective of this project was to improve system reliability, reduce maintenance costs, reduce the impact to the environment and extend the useful life of transformers by curtailing wildlife caused outages on AltaLink substations. The project team included personnel from several departments (Maintenance, Environmental Protection and Engineering) as well as experts from a manufacturer, Cantega Technologies. The process was highly collaborative; needs were defined and the manufacturer developed a protective system that achieved the targeted results. Particulars follow.

It has long been recognized in the electrical utility industry that transformers are one of the most critical components making up the power system. Transformer costs make up the largest single investment when building substations to supply our electrical distribution systems. It is therefore conceded that preventing transformer failures is a high priority in terms of managing the assets of the power system. We are now concerned with two dominant factors facing the power industry, an aging infrastructure and increasing load demands. The aging infrastructure is a product of high growth periods during the late seventies and early eighties resulting in the majority of our transformers nearing end of life at the same time. The increasing load demand is a product of the industry not keeping pace with growth due to their preoccupation with deregulation of the power industry.

Why do Transformers Fail

There are two main contributing factors to transformer failures, neglect over a long period of time and multiple or singular events causing distress to transformer components. Neglect of the oil can lead to deterioration of the solid insulation in conjunction with moisture ingress, which can result in a shortened life. Transformers exposed to numerous thru-faults due to animal contact, poor low side bus design, contamination, or excessive reclosing into faulted buses have a higher probability of failure than those not exposed to these conditions.

The illustration below shows the effect numerous thru-faults have on the life of a transformer as it ages, we all know as a transformer ages it has less mechanical and dielectric withstand capability. In addition to less withstand capability aged transformers under increased loading due to system growth are subject to more operating stress. In other words the stress events become more severe just when your transformer may be most vulnerable.

Illustration # 1
Effect of Numerous Thru-faults on Aging Transformers

Hartford Steam Boiler has collected statistics indicating the three main failure causes are:

- Electrical Disturbances 37.2%
- Lightning 21.9%
- Insulation Issues 12.4%

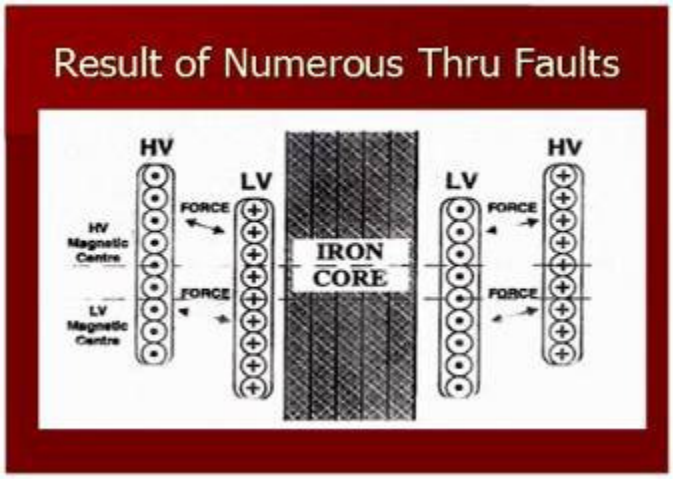
Electrical disturbance is a very general term so we can clarify by breaking down further into categories including:

- Switching Surges
- Voltage Spikes
- Line Faults
- **Insulation Flashovers.**

Line faults and external insulation flashovers cause electromechanical stress to the windings resulting in an electrical failure.

In illustration # 2 we can see the failure mechanism from large increases in current flow (thru-faults).

Illustration # 2
Failure Mechanism of Thru-faults



Loss of clamping pressure due to excessive thru-faults or aging and shrinking paper insulation will eventually lead to deformation of the coils and failure. The failure probability also increases with the frequency and severity of these thru-faults especially on aging transformers.

Illustration # 3 shows the high voltage winding after a thru-fault caused by a raven contact on the low voltage bus of a power transformer.

Illustration # 3
Thru-fault Initiated Failure Due to Bird Contact of Low Voltage Bus

Increasing Reliability and Reducing Transformer Failures Caused by Wildlife Contact

Recent data for several utilities indicate animal or bird induced thru-faults can contribute between 15-20 percent of all failures. AltaLink's own reliability statistics show over the past several years bird contacts were accountable for 17% of outages and the majority of 25Kv bus outages. In most cases we discover poorly designed low bus configurations or inadequate phase to ground spacing contributes to the events.

We have made great progress in developing new technologies to assist in assessing the condition of our aging transformer fleet. We have SFRA (Sweep Frequency Response Analysis), on line partial discharge monitors, on line gas monitors, and many more. These are all designed to help us determine if the transformer is in serviceable condition or do we need to replace the unit. Typically these tests are performed after an event and in most cases this event was a thru-fault seen by the transformer. An effective and inexpensive way to lower the probability of phase to ground and phase to phase faults on low voltage bus designs susceptible to animal induced faults is to install a wildlife outage mitigation system.

Installation of a wildlife outage mitigation system has three major benefits:

- It reduces thru-faults on our aging transformer fleet
- It reduces bus outages, which typically cause outages to a large number of customers with extended restoration
- It reduces our impact on the environment.

The project team determined that an effective wildlife outage mitigation system should have the following characteristics:

- It should be based on detailed engineering standards to ensure consistency across the system.
- Results should be quantifiable and measured.
- It should be applied consistently to retrofits and new construction.
- It should enable a custom solution to be developed for each individual substation that addresses the risks specific to that substation.
- It should be based on a technology that produces protective covers that fit tightly. The covers should be customized to fit the components requiring protection as opposed to being loose fitting. (Bird's beaks and squirrel's claws can extend into openings and cracks.)
- The covers should be easily installed, as well as be easily removed and re-installed to enable ongoing maintenance.
- The covers should be robust, have excellent UV resistance and good dielectric strength as well as be resistant to contamination build-up.
- The protection should be visible and aesthetically attractive.

The end result of this collaboration was a wildlife outage mitigation system based on Cantega's unique Greenjacket fabrication technologies, which enables Cantega to cost effectively manufacture protective covers customized for specific equipment. Greenjacket protection was first installed at an AltaLink substation in 2003 and is now installed to some degree in 40 of our 270 substations.

The project team was awarded the 2007 "Presidents Award" at AltaLink for innovation. In addition, AltaLink was also recognized by the Canadian Electrical Association's Environmental Commitment and Responsibility Program as an outstanding environmental initiative.

The product has been tested by Powertech Labs. Inc. of Surrey, British Columbia Canada for several parameters including dielectric breakdown, effect of the product on bus temperature rise and hot-spot detection.

AltaLink has in place a prioritized installation program based on outage statistics indicating the substations experiencing the highest number of bird related outages in addition to standardizing the product to be installed on all new installations of outdoor bus 23Kv and below. These components could be at line potential or ground potential depending upon the design and what type of fault you are trying to prevent (phase to phase or phase to ground). A typical installation is shown in Illustration 4.

Illustration # 4
Installation of Covers to Prevent Bird Contact

Summary

Increased load factors and fault currents at a time when the majority of our transformer fleet is reaching their end of life expectancy is increasing the risk of failures. The mechanical strength of these units, which contributes to their ability to withstand life threatening thru-faults, is diminished. The application of a wildlife mitigation system that incorporates bottom up asset management methodologies reduces the probability of a thru-fault occurrence, improves reliability statistics and maximizes the useful life of core assets.