Equipment Reliability Modeling for Power Producers

Introduction

Equipment reliability is an important issue for any business that relies on machines to create or deliver its products or services. For power producers, the stakes are even higher. With 24-7 demands to meet, significant costs for downtime, and large and complex equipment systems to maintain, their challenge is great.

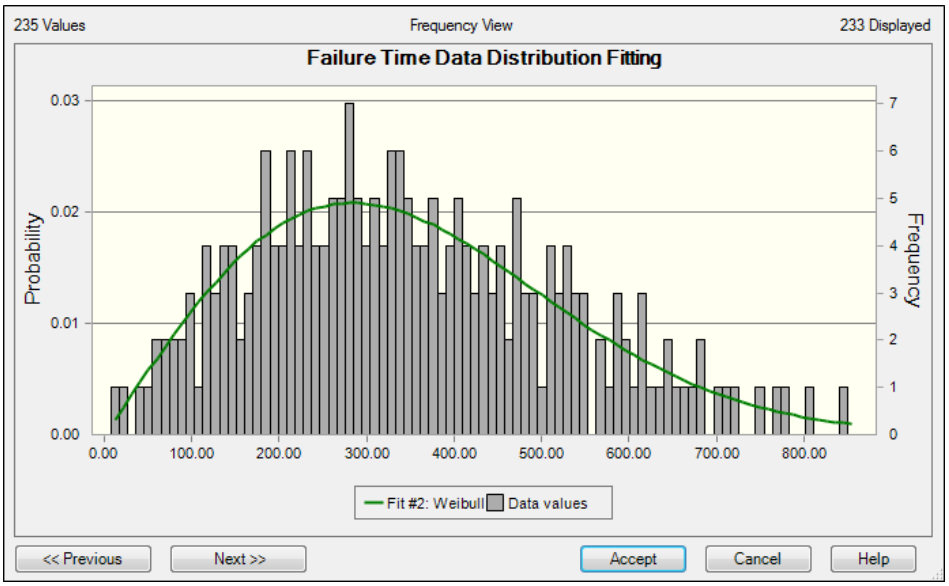
To minimize downtime, power producers have depended on the experience and expertise of their workplace leaders to predict equipment failure times and select maintenance intervals for critical equipment. This insight has been invaluable in improving reliability performance; however, to drive further improvement, more sophisticated methods will be required.

The technological tools available today allow us to efficiently utilize statistical techniques to evaluate the historical performance data of equipment, and in so doing, to predict the future performance of that equipment. Unlike the input from individuals close to a process, the models do not over-react to a string of "bad luck" in equipment reliability, nor do they ignore a failure because it hasn't occurred during the tenure of the process expert. The resulting distributions for the time-to-failure for equipment may drive changes to the maintenance philosophy, parts stocking levels, and other variables that can create significant value for the companies that employ these techniques.

One power generating company that adopted these techniques in 2010 identified an annual opportunity of $570,000 based on a change to the preventive maintenance frequency interval for a single equipment category. Additional savings are expected as the spare parts inventory is optimized and the methods are applied to additional equipment categories.

What is ERM and How it Works for You

Equipment reliability modeling is the process of describing mathematically the likelihood of failure of equipment and using that information to optimize business decisions. The process begins with the modeling of equipment failure times. This analysis is ideally completed using historical failure data. Based on the type of maintenance (repair/replace) and the data themselves, the most appropriate model is selected. For simplicity, we consider here only the scenario when the equipment is either replaced or considered "as good as new" following repair. In this case, a probability distribution is fitted to the historical time-to-failure data. This probability distribution then becomes the input for models used to predict failure times and to optimize maintenance frequency and other variables. Care must be taken and appropriate statistical methods applied to handle the data, particularly censored/suspended data points, where the failure time is not known.



Using Monte Carlo simulation, thousands of failure time scenarios are calculated within models that are developed to evaluate the outputs of interest, which may include items such as maintenance costs, downtime, lost production, etc.

An additional level of analysis can then be completed to determine the optimal values of "decision" variables, those items within the organization's control which also contribute to the resulting values of output variables of concern. Decision variables could include items such as time between inspection or maintenance on a piece of equipment and the number of spare parts to stock.

Business leaders are then able to use these results to make the optimal decisions, saving their organizations up to hundreds of thousands of dollars per year or more. As other costs rise and budgets are reduced, making wise choices about items such as these can certainly provide a competitive advantage.

Journey to ERM

Businesses have been using the expertise of their employees for years to estimate the time to failure of equipment. Based on those estimates, they have made decisions regarding the repair and replacement of that equipment, inventory levels, and other business critical issues. ERM applies a more rigorous approach to address the same questions using data and modeling.

For companies interested in pursuing ERM, the first step is to identify equipment failures. In some cases, failure events may not be explicitly tracked. In that case, it may be feasible to infer the times of failures by investigating and consolidating information from multiple data sources. In the long-term, a single consolidated database used to track equipment failures is a more efficient solution.

In the early phases of ERM application, the goal may be to describe the probability of failure of a piece of equipment by a certain point in time. This information can be useful when the opportunity to perform preventive maintenance on equipment is limited to a rare outage event, and the cost of maintenance must be balanced with the cost of equipment failure.

As the use of ERM matures, more complex models can be developed to optimize items of interest and answer questions such as: What is the optimal maintenance interval? and What is the risk associated with carrying a particular level of spare parts?

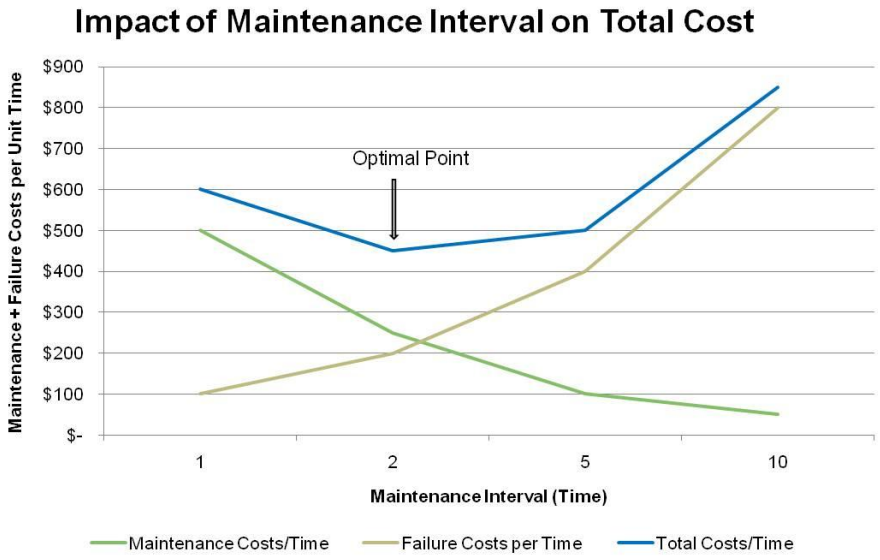
Successfully applying these methods does require a certain level of expertise; however, the concepts driving the method are simple enough to understand. The time that a particular piece of equipment will fail is uncertain, and we assume it follows a probability distribution. By simulating the actual failure time in thousands of trials, we can consider what might happen, including what might happen when particular decisions are made.

The successful application, of course, depends on more than the data or even the modeling. In order to achieve significant financial gains, the business leaders must be willing to make decisions based on the results of the modeling.

Return on Investment from ERM

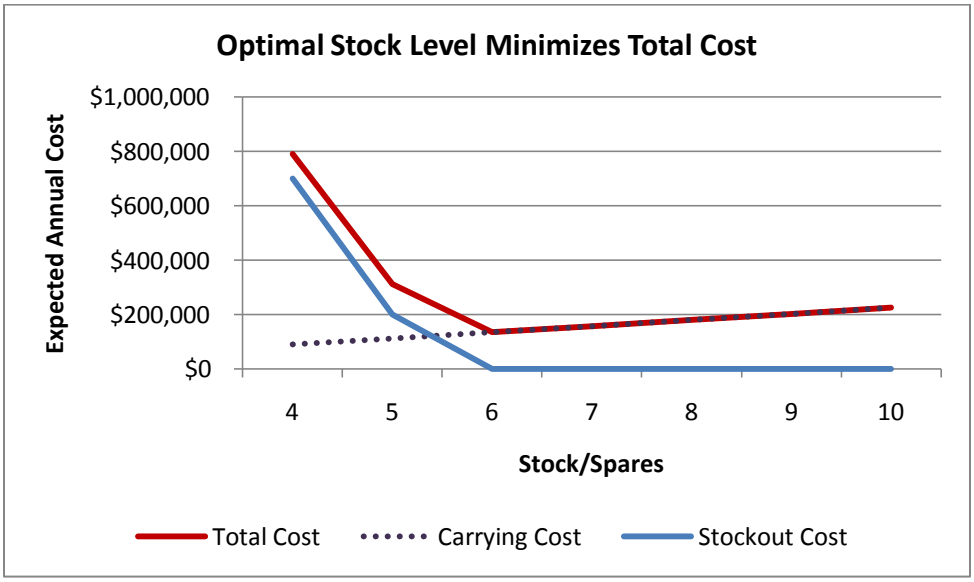
There are a number of ways that utilizing ERM can contribute to the bottom line for power producers and other businesses. Here we'll discuss two of the most striking opportunities.

In order to minimize the total cost of maintenance, the cost of both preventive maintenance and equipment failures must be considered. When the likelihood of failure increases over time and the cost of an equipment failure exceeds the cost of preventive maintenance, it will be optimal to perform preventive maintenance at some interval.



The length of the optimal interval depends on the costs for failures and preventive maintenance actions as well as the time-to-failure distribution for the equipment. Performing the preventive maintenance too often results in unnecessary maintenance costs, while making the interval too long results in additional failures and their associated costs. ERM allows us to locate the "sweet spot" that balances the need for reliability with the cost of achieving it. Depending on where the business is currently operating, utilizing ERM and the associated results can provide significant reductions in equipment failures or preventive maintenance costs.

Another key opportunity provided by ERM is related to spare parts inventory. With the probability distributions describing the time-to-failure of equipment determined, the parts stocking levels can be optimized to minimize total costs, including costs of carrying the inventory and the costs of a stockout, or not having a part when it is needed. Savings then may be achieved by eliminating unnecessary inventory or by increasing stock levels to reduce the likelihood of a stockout and the associated lost production costs.



Since the time-to-failure information is fitted to a probability distribution, simulation can be used to determine the likelihood of a particular outcome given a certain level of inventory. For example, these models can tell the user that there is a 75% probability of a stockout in one year at a particular stocking level. Over a large system, these risks can be objectively compared in order to determine the most strategic investments, reducing waste and maximizing uptime for the system as a whole.

Conclusion

As technology improves and competition becomes fiercer, power producers will benefit from taking advantage of opportunities to minimize their costs and improve their reliability. Equipment reliability modeling is one way to achieve step-wise gains in these areas.

The models provide information about the time-to-failure of the equipment which can be used to optimize decisions related to maintenance and parts stocking, creating significant savings for power generation companies.

When your company is ready to take the next step towards data-driven decision-making, choose a critical equipment category, locate the failure data, and work with an expert to see for yourselves how ERM can help take your business to the next level.

About Black Belt on Demand

Black Belt on Demand helps businesses and individuals be more effective, make better decisions, and succeed in ways they might not have realized were possible using tools including Six Sigma, Monte Carlo simulation, data analysis, and coaching for individual clients.

We bring exceptional experience and knowledge to every project. We enjoy providing the flexibility required to meet the needs of small businesses and teaching our clients as much as they want to learn about the processes we utilize.

Contact us to learn more about how equipment reliability modeling can improve your bottom-line.

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