Savigent SOFTWARE

CASE STUDY

Pump Monitoring System

Industry

Semiconductor Manufacturing

Application

Savigent Platform™

Background

This semiconductor manufacturer utilizes over 200 cryopumps during manufacturing operations. Cryopumps represent a significant hardware investment and a critical process step in this manufacturer's operations, so keeping them running correctly is critical to efficient operations and maintaining a low scrap rate.

Challenge

The biggest challenge with the pump monitoring system project was to execute the project within a very limited budget. This included replacing an expensive third party monitoring system, increasing the percentage of pumps that were monitored, and building a system that was flexible enough to accommodate future requirements.

Results

This manufacturer used a small team of internal IT resources to replace the existing third party pump monitoring system with a Savigent Platform-based solution, saving over $12,000 per month and increasing the number of pumps monitored from 50 percent to over 75 percent.

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Introduction

A cryopump is simply a vacuum pump that traps gases and vapors by condensing them on an extremely cold surface. They are only effective on some gases, depending on the freezing and boiling points of the gas relative to the cryopump's temperature. As the cryopumps work, the trapped gases build up on the condensing surface and must be periodically evaporated for the cryopump to continue to work effectively. This process is referred to as regeneration. Tracking regeneration cycles as well as monitoring pumps to predict equipment failures are critical to operational efficiency.

In the Target Maintenance Tracker case study we examine how this same semiconductor manufacturer established a Preventative Maintenance System, called the Target Maintenance Tracker, using Savigent Platform. In this case study we focus on how their initial investment in the Target Maintenance Tracker was leveraged to easily replace a third party cryopump monitoring system that was costing them over $12,000 per month in monitoring.

Problem Statement

The main motivation to undertake the pump monitoring system project was to eliminate the recurring expense associated with the third party cryopump monitoring service. The third party monitoring system was only used for about 50 percent of the cryopumps in operation and cost nearly a $150,000 dollars annually. Equally important is the ability to predict when maintenance might be needed on the cryopumps by monitoring a number of variables. This ability to predict when maintenance is needed prevents catastrophic failures that will hurt production throughput and saves costly equipment repairs.

The existing monitoring system was also difficult and expensive to enhance, which was demonstrated when the manufacturer expressed a desire to add and monitor vibration sensors to several critical cryopumps. This prompted the customer to look for an internal solution that would allow for economical monitoring all of their cryopumps in a way that would realize the benefits of a Predictive Maintenance System, as well as provide easy extensibility for future monitoring requirements.

Critical project success factors were identified as follows:

- Project costs needed to be kept as low as possible
- Percentage of cryopumps that were monitored needed to increase from 50 percent to 75 percent
- Extensibility of a new system was key to meeting future requirements

Solution

Overview

The decision was made to use internal IT resources to leverage the existing Target Maintenance Tracking System to build out a new Predictive Maintenance System for monitoring the cryopumps. This new system would monitor 19 key attributes for each pump and compare these values against upper/lower warning and upper/lower alarm limits to predict when maintenance was needed for a particular pump. The system would then notify the appropriate personnel via email or pager.

Project Team

Savigent Platform enabled this customer to utilize an internal team of one senior level IT resource and one intern to do all of the development for the system. In addition one hardware specialist was used to support the team at deployment time. This small project team was a key to controlling project cost and allowed the development effort to be nimble and responsive to changing requirements.

Leveraging Existing Infrastructure

There were two pieces of the architecture that were reused from the Target Maintenance Tracker project that significantly reduced cost and implementation time for the Pump Monitoring System. These two pieces of infrastructure are described below:

Entity/Attribute Model

During the Target Maintenance Tracker project an abstraction was used to model a piece of equipment as an entity with a unique identifier. Then a collection of attributes were described and associated with a particular entity. This provided the system a way to generically describe any piece of equipment, even though they all had a dissimilar set of attributes. This model was used to describe the attributes of a cryopump some of which include:

- Operating temperature
- Rate of change of operating temperature
- Pressure
- Vibration
- Power consumption (current draw)
- Number of failed regeneration cycles
- Total hours of use
- Total hours since last regeneration

Notification Infrastructure

Another area of reuse gained from the previous project was the notification infrastructure. This allowed the Pump Monitoring System the ability to notify the appropriate personnel of warning or alarm events when a pump was indicating that it will soon need maintenance, or that it had failed and required immediate maintenance. This subsystem sends warnings and alarms to maintenance personnel via email or pagers.

Simplifying Deployment

One of the challenges with the Pump Monitoring System project involved deployment cost. Each pump had a Programmable Logic Controller (PLC) with serial ports for outputting data. The implications of this meant locating a computer next to each cryopump just to monitor the data required for predictive maintenance. Since this would drive up hardware costs and use valuable manufacturing floor space, a more creative solution was needed. The development team came up with a solution to use a third party technology that exposes serial ports to the network. This allowed all of the data from all of the cryopumps to be available via standard network communications. The deployment flexibility inherent in the Savigent Platform runtime then made it possible to use one physical server to run a unique solution on behalf each cryopump. This single server approach dramatically reduced the hardware costs of the project and greatly simplified the deployment model.

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Challenges

Budget Constraints

Savigent Platform's intuitive programming model and mild learning curve made it possible for the customer to use internal IT resources, thereby controlling project costs. By keeping the team small and nimble, they were able to start monitoring the most critical pumps first and realize value from the investment before funding the entire project. This reduced project risk and helped build confidence in a successful outcome.

Savigent Platform's highly component-based development model enabled the team to leverage the previous project's infrastructure, which allowed the team to focus on the getting the appropriate data off of the cryopumps and monitoring that data rather than creating a new notification infrastructure from scratch. The reuse from the notification infrastructure and the entity/attribute model significantly reduced overall development time.

Deployment Complexity

Savigent Platform's extreme deployment flexibility, combined with the creative thinking of the development team reduced hardware requirements down to a single server, thereby minimizing hardware costs and ongoing system maintenance costs. In addition, this deployment model helps conserve valuable factory floor space.

Ongoing Extensibility

The ongoing extensibility that the previous third party system lacked now exists in the new pump monitoring system. The Entity/Attribute infrastructure makes adding and monitoring new attributes a simple task that is easily accomplished with internal IT resources.

Results

This project was successfully implemented with a small team of internal IT resources very economically. The hardware cost was minimal due the deployment flexibility that Savigent Platform provided, which allowed the virtual serial ports on all of the cryopumps to be monitored with logic that was customized for each pump when needed, but centralized on a single server. The development cost was minimized by gaining significant reuse from a previous project implemented with Savigent software.

The result was a cost elimination of nearly $150,000 annually in third party monitoring and an increase in the percentage of pumps monitored from 50 percent to 80 percent. By implementing this predictive maintenance system to monitor their cryopumps, this customer:

- increased throughput by reducing downtime;
- reduced their scrap rate; and
- reduced maintenance costs on the cryopumps by identifying maintenance problems before they led to catastrophic failure.