GE Fanuc Automation

Implementation of a Real-Time Overall Equipment Efficiency (OEE) Index in a Paper Mill

A News Print Mill's paper production machines were outdated and comparatively small by current market standards. Due to the decrease in newsprint market price and the increase of competition in North America, the Mill embarked on a real-time OEE project to increase plant efficiency for one of its paper production machines. System Technologies for Industry (STI), a GE Fanuc Premier Solution Provider, was called upon for the project using GE Fanuc's Proficy Plant Applications software.

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Project Objectives
The project's key objectives were as follows:
- Implement a complete real-time OEE system for a pape machine
- Track the real-time loss of time, performance and material through hourly summaries (a real-time screen needed to be available to all personnel in the Mill to provide summaries for the three key performance indicators and to monitor differences between theoretical capacities and real capacities)
- Capture events from the control systems automatically so that no events are forgotten
- Publish OEE reports using the intranet (using Internet Explorer) to the entire Mill. These reports will state the ten primary reasons for downtime, performance losses and material loss at any time.

Software
GE Fanuc's Proficy Plant Applications – an MES (Manufacturing Execution System) software solution.

Description of the Application
The application needed to capture data from a process data historian that is connected to the Mill's control systems. All efficiency events had to be captured automatically and indicate the start and end time of all events. In order to select reasons for downtime, the operator must choose from a drop down list for the event, three levels deep. He or she may also add a comment to the event. For some of the material losses, a link will be created to the roll-tracking (sales order) system to indicate the trim loss. Some of the material losses will be automatically calculated with downtime reasons. Calculations will be done hourly with summaries provided at the end of the day and month.

Summary
STI was asked to provide a system for the paper mill that allowed them to:
- Capture events automatically
- Manually select downtime reasons
- Link to the roll-tracking system for calculating some of the material losses
- Generate a real-time OEE screen for personnel giving hourly and daily overviews
- Calculate hourly summaries
- Access a report of the current Mill status via the intranet at any time. The user must be able to select a machine, grade, and period of time and obtain the full OEE report

OEE (Overall Equipment Efficiency) Summary
The OEE index, which was used to calculate the plant's efficiency as a result of this project, can be summarized using the following weighted calculation:

Overall Equipment Efficiency index = Availability x Performance x Quality

This calculation gives the OEE of the machine or the Mill where:

Availability measures available TIME for the machines.

Examples:
- Equipment failures (downtime)
- Maintenance (scheduled and unscheduled)
- Etc.

Performance measures THROUGHPUT (comparing the speed of the machine with the theoretical speed for this specific grade).

Example:
- The speed of machine may be slower because of a shortage of raw material or energy

Quality measures MATERIAL loss.

Examples:
- Trim losses
- Rejected rolls
- Grade change losses
- Slab losses
- Etc.

Before: A Manual Efficiency Tracking System
Prior to this project, the Mill had a manual efficiency tracking system. Operators were required to enter events and reasons for downtime manually. Log sheets were collected and consolidated in Excel spreadsheets and results were made available at the end of the week or month. The manual system provided an after-the-fact picture of the Mill status, and results were completely dependent upon the consistent manual entry practices of the operators.

Limitations of Manual Systems
Manual systems "forget" events. They have a tendency to filter out high frequency (short duration) events because of the manual work involved to track these frequent occurrences. If operators are busy troubleshooting, they may not

have time to log events consistently or accurately. If an event generates a lot of paperwork, it tends not to be tracked. The second very important limitation is that manual systems are not capable of tracking in real-time. Results are not known until the end of the week or month. There is therefore no opportunity to react in real time to a problematic situation on the shop floor. The third limitation of manual systems is that some events cannot be tracked manually because of the speed of the process and the quantity of information to be logged. The manual system will incorrectly indicate a higher efficiency than truly exists.

Challenges

Migrating manual calculation estimations to a real-time system was the first technical challenge in a project of this scope. The calculation that uses the basis weight average for the day and the calculation that uses the machine basis weight every minute do not give the same results.

Second, because of the real-time situation, data filtering was often required. The overall project lasted four months: three calendar months of development and one month of calculation iterations to fine-tune the calculations and the data filtering.

The last challenge was the need to recalculate past values when new decisions were made. For example, if the reason selected for downtime on the machine previously was "Maintenance" and this was later changed to "Operations," all of the statistical summaries that had been performed needed to be updated. If this was the end of the month, the monthly summary had to be updated as well. If it was in the last quarter, the quarterly summary had to be updated too.

Critical Success Factors

In order for the project to be completed successfully, a number of critical commercial, organizational and technological success factors needed to be in place.

Commercial Critical Success Factors

Management clearly communicated the objective to the stakeholders before project implementation, the paper machine had a 77% OEE rate, and key stakeholders were asked whether the machine should be shut down or improved. It was decided that the machine would be improved.

Organizational Critical Success Factors

Selecting an internal "champion" that had credibility with Mill management was the first critical success factor. The person needed to verify event numbers and had to be able to defend them with management and the different departments. [Mill management initially rejected the numbers generated by the newly implemented system because it showed lower efficiencies than the previous manual system. This is normal because an automated, real-time system exposes lower efficiency and does not forget events. It also tracks events that cannot be tracked manually. In order to confirm the event numbers, the Mill appointed an internally credible individual to verify the data. This was one of the most important critical success factors in the project. After verification, this person explained to management the differences between automatic and manual systems and that the real-time numbers were correct. The system gained credibility after this.]

This individual also had to measure the Maintenance, Production and Technical services departments by the complete OEE number. [This changed behaviors in interesting ways. Scheduled maintenance actually increased. This decreased the availability of the machine (one of the components of OEE) but increased the overall OEE of the machine.]

The last critical success factor was in creating a team of people who could utilize the information. The system is only an enabler – it does not solve the problems. It will indicate where it is necessary to focus problem solving. In this case, the Mill wanted to be an industry leader. Its motivation was a requisite for success.

Technological Critical Success Factors

A high quality MES system was required that could do the following:

- Capture data automatically from the control systems
- Capture reasons for downtime
- Have full intranet/internet reporting capability
- Have the capability to recalculate past historical values continuously

Using the Mill intranet for information distribution was key to the project's success. Easy accessibility to information is extremely important and a key feature for Mill personnel to adopt the system.

For this project, the Proficy MES system from GE Fanuc was used successfully. The system delivered very well on the listed requirements.

Payback

The first payback was time. There is no longer a loss of time in performing the following critical functions:

- Capturing data
- Making calculations
- Discussing the validity of the data and the calculations

Second, there is now one snapshot of plant efficiency in real-time so that plant personnel can be more accurately evaluated. The second payback is in the capability to act in virtual real-time and not after-the-fact. A situation that creates an efficiency loss is reported quickly, as is an indication of the specific downtime reason. Action is now possible almost immediately, and the status of the machines and the reasons for downtime are propagated in real-time throughout the Mill.

The third payback comes from the fact that plant personnel know exactly where to act to increase efficiency. The system gives the primary reasons for downtime, loss of performance and material loss.

The documented increase of this paper machine was 6% over six months (from 77 to 83% OEE). The Mill is now extending the use of the system to other paper machines and the pulp lines.

Conclusion

This project was successfully implemented in a News Print Mill. The objective was to track in real-time and in an automated manner the following key performance indicators on a paper machine:

- Availability (equipment failures and maintenance)
- Performance (speed of machines)
- Quality (losses from trim, rejected rolls, grade change losses, etc.)

The Mill had a manual tracking system and was migrated to a fully automated system. GE Fanuc's Proficy Plant Applications solution was implemented in order to compare the theoretical capacity and real production capacity of the machine every hour.

Today, the reasons for the differences between theoretical capacity and reality are indicated and logged. Continuous improvement teams can now work on the primary reasons for downtime, performance and quality problems. All efficiency data is archived for long-term data analysis. And wide-scale distribution of efficiency information in the paper Mill is achieved by publishing reports on its intranet.

OEE of the machine before and after the project was calculated using the Overall Equipment Efficiency index (Availability x Performance x Quality.) After an initial OEE index of 77% prior to the project, STI and GE Fanuc's Proficy Plant Applications software helped the plant register a 6% gain (83% OEE) over the next six months.

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