Written by David Liptrot, Ivara Corp. and Gino Palarchio, Dofasco Inc.
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Dofasco used innovative practices and technologies to completely change the way its maintenance departments operate. Here is an overview of the process that has helped increase equipment availability and product quality yield.

Knowing what is the right maintenance program for a company's assets is no easy task. It might seem that the longer the company has been around the more effective its maintenance program would be. Unfortunately that assumption is not always true. In fact, the effectiveness of the maintenance program has absolutely nothing to do with the number of years the company has been doing maintenance. Most companies are doing too much maintenance too early, or too little too late, either of which has cost consequences to the organization.

Most organizations are continually attempting to improve their bottom lines through improved maintenance practices. Why do only a few achieve their objectives? Unfortunately, trying to improve without the right business focus, alignment of practices, and enabling tools can make matters worse. The required information and know-how for the most part already exists in the company but is so scattered throughout the organization that inconsistency rules.

Dofasco, Inc., formulated advanced maintenance practices and combined information technology to develop a unique equipment reliability program that has made a significant impact on the company's bottom line. Canada's second largest steel manufacturer, the company produces 4.5 million tons of flat-rolled steel a year. The company has revenues of more than $3 billion and employs 7000 people in its Hamilton, ON, plant. The plant's equipment replacement value is $5 billion.

Motivation to improve

In the 1980s the steel business was good. However, in the late 80s and early 90s circumstances began to change. Globalization was beginning to influence the market, imports started arriving at lower prices and higher quality, hangover from the 1970s inflation saw costs rising and prices dropping, there was a shift from a seller s to a buyer s market, and shareholder returns were beginning to erode.

Dofasco took a step back and evaluated its maintenance performance and found that 70 percent of maintenance work was reactive and only 30 percent was proactive. The rate of product quality improvement was flat, and average equipment availability was only 78 percent. At that point managers realized that equipment reliability was vital to improving product quality, production output, costs, and shareholder return. They initiated a strategic project to research, develop, and implement the most advanced maintenance practices and information technologies to achieve maximum equipment reliability.

The project

As they started the project they found four main issues that had to be addressed:

- The existing culture stressed equipment repair over asset management. They needed to adopt an equipment reliability business process.
- Many improvement efforts were ongoing in the plant, but they were inconsistent. Dofasco decided to develop a critical few fundamental business practices.
- The ongoing improvement efforts were typically short lived. They needed to develop a sound implementation methodology.
- Islands of data were not readily available to maintenance. Data systems needed to be integrated with expertise to convert the data into usable information.

The ability to come up with an innovative software system to support the first three requirements was going to make or break the initiative.

The practices

The company was in a fairly typical situation. Information was scattered throughout the organization in the form of original equipment manuals, computer databases, experience and knowledge of tradespeople, and many reports. However, none of the information was easily accessible to the people who planned the maintenance work; the result was inconsistent actions. The planners had no way to know what work they should be planning at what time.

By developing an equipment reliability business process, Dofasco believed that it would be able to identify the knowledge or information that needed to be managed. Establishing business practices would ensure consistent behavior to support the business process. A sound implementation methodology would allow planners to extract the required knowledge and make it easily accessible to everyone, resulting in consistent action or the ability to do "the right work at the right time." And finally, an enabling information infrastructure would help turn the data into usable information.

The equipment reliability business process they developed revolves around quality issues. The processes that made up the overall equipment reliability business process were quality planning, quality improvement, quality control, and quality assessment.

The next step was to develop practices to support these processes. The practices involved in quality planning were designed to ensure that personnel understood business unit goals and how assets would contribute to these goals. By understanding this they could now target equipment reliability efforts on the assets that contribute to business unit goals.

Quality improvement practices were designed to ensure they were identifying the proper maintenance program for their assets. Work identification is fundamental to equipment reliability because if the proper work is not identified, other practices are irrelevant.

Quality control practices address the efficiency of the maintenance department. Again, without proper work identification the quality control process does not matter. Technicians will just be doing the wrong work more efficiently.

Quality assessment practices assess the work that has been done to determine if the work was accurately identified in the first place. They provide an opportunity to continuously improve work identification practices.

At this point the company had a process and practices to support it, but the next step was the most difficult implementing the processes and practices. The implementation methodology involves 10 steps. An implementation step addresses each of the business processes that had been defined. The steps include reliability-centered maintenance (RCM) analysis, predictive maintenance needs assessment, criticality analysis, and hierarchy development.

The technology

Once the practices were in place the company needed a computerized system to help ensure that these new practices would be easy to follow. One of the first tasks was to define content versus computer. The business process, business practices, and implementation methodology all ensured that the content of maintenance work is effective at achieving equipment reliability. The computer system would act as an enabler in conducting the business process and business practices most efficiently.

The company already had a computerized maintenance management system (CMMS) but determined that this program could not satisfy all of its needs. A CMMS is work-order based and is really about improving maintenance efficiency. Therefore it addressed the quality control aspects of the processes (work planning, work scheduling, and work execution).

However, something was needed to help identify what work needed to be executed and the right time to do it.

After unsuccessfully searching for a commercial package that could satisfy its needs, Dofasco decided to develop its own system. The result was the Intelligent Condition Monitoring System (ICMS), which is being commercialized and marketed by Ivara Corp. under the name Ivara.EXP (Expert Maintenance Program). This software supports the quality planning and quality improvement processes that were in place. It helps manage the effectiveness of maintenance operations and complements the existing CMMS.

The ICMS software collects the islands of data and analyses the information by using expert systems technology. It predicts potential problems and triggers an alarm to pinpoint the specific problem. Once it has identified the problem, it recommends the corrective action needed to prevent equipment failure.

The ICMS system collects a variety of information, such as visual inspection results, operator observations, vibration characteristics, process parameters, lubricant test results, electrical diagnostics, and thermographic images and trends. The data are collected electronically where possible by integrating to predictive maintenance devices and data historians. In other situations the system uploads to handheld data loggers to allow people to conduct accurate and efficient inspections.

The ICMS system then analyses the data using defined rules and triggers alarms as necessary. The planners can then use the information provided and review graphs showing trends on the asset. They send out a work request that triggers a work order in the CMMS. The work is then planned and scheduled for tradespeople to execute.

The key concepts that the system addresses:

- It consolidates and leverages maintenance and operations data and makes the information usable
- It captures plant expertise in a comprehensive equipment maintenance program (EMP) that includes preventive, predictive, and corrective activities
- It provides immediate visibility of problems that can be traced back to the data that triggered the alarm
- It integrates with the CMMS so that planners do not have to duplicate efforts in two systems.

Everything starts with the EMP. Planners identify the preventive, predictive, and corrective activities that need to be performed on an asset. They set up inspection templates, preventive maintenance routines, and standard jobs to make setup easier. The computer captures all relevant information for an asset, including what activities to perform and how often and when they were last performed.

The EMP also allows planners to set up equipment condition indicators. These indicators can come from metered or predictive technology readings such as temperature, mileage, pressure, and vibration as well as from visual inspections, and allow them to capture consistent information such as clogged, cracked, or normal. Once planners have specified the condition indicators to track on an asset, they can set up the rules that will trigger alarms and the recommended actions to take when alarms are triggered. The rules can include calculations such as engineering computations as well as failure modes, which combine multiple indicators.

Dofasco does use reliability-centered maintenance, so they devised the system to provide full support for RCM methodology linked directly to the EMP. This arrangement allows planners to see if the task they are performing is based on their RCM analysis.

Data are collected in a variety of ways. For example, operator checksheet data used to be kept on clipboards near the equipment and was rarely used by maintenance. Now operators help monitor equipment condition by entering their checksheet data into the computer system.

Planners also collect inspection data from tradespeople and technical staff. Before the new system was instituted, a person would be given a work order that said "Inspect Boiler 3." The inspector would then enter comments on the work order such as "OK." Planners could not do anything with this information.

Now inspections are defined with equipment condition indicators. The inspector gets a paper checksheet, or downloads the checksheet to a portable datalogger that has a predefined list of choices. This strategy ensures that inspectors collect uniform data that can be used to analyze equipment condition. The inspector also gets immediate feedback on any alarms that are triggered while he is entering data. Thus he can ensure that he is entering valid data, or he can fix the problem immediately if possible.

Condition indicator values also are extracted from predictive technologies such as thermographic peak and vibration resonance. Other condition indicator values are collected from plant floor data collectors such as data historians, programmable controllers, and distributed control systems. All of these methods are used to collect the right data at the right time to ensure that equipment is performing as expected.

Then the data can be used to make informed maintenance decisions following rules defined in the EMP. These rules trigger alarms and recommend corrective actions when equipment is performing outside of desired operating parameters. Nonnormal equipment status is readily visible to maintenance personnel. They can then examine and analyze trends in the condition data. If necessary, corrective actions can then be taken to return the equipment to its desired operating state.

The results

Dofasco used these innovative practices and technologies to completely change the way its maintenance departments operate and saved millions of dollars. They now do 75 percent or more proactive work. Equipment availability increased more than 10 percent and product quality yield rose from 76 to 91 percent. The maintenance workforce has declined, through voluntary attrition, from 3678 to 1734. The parts inventory was reduced from $110 million to $70 million with a goal to get to $50 million by 2001.

At the recent 11th Annual Canadian Maintenance Management Congress in Toronto, Dofasco walked away with two prestigious awards. The first was for Best Maintained Large Plant/Facility and the second for Best Use of Technology/Maintenance Innovation of the Year.

In March 1999 Dofasco joined with Ivara Corp., a leading developer of enterprise asset management solutions, to bring this innovative technology to market. **MT**

David Liptrot is marketing manager at Ivara Corp., Burlington, ON; telephone 905-632-8000 ext. 249. Gino Palarchio is equipment reliability manager at Dofasco Inc., Hamilton, ON