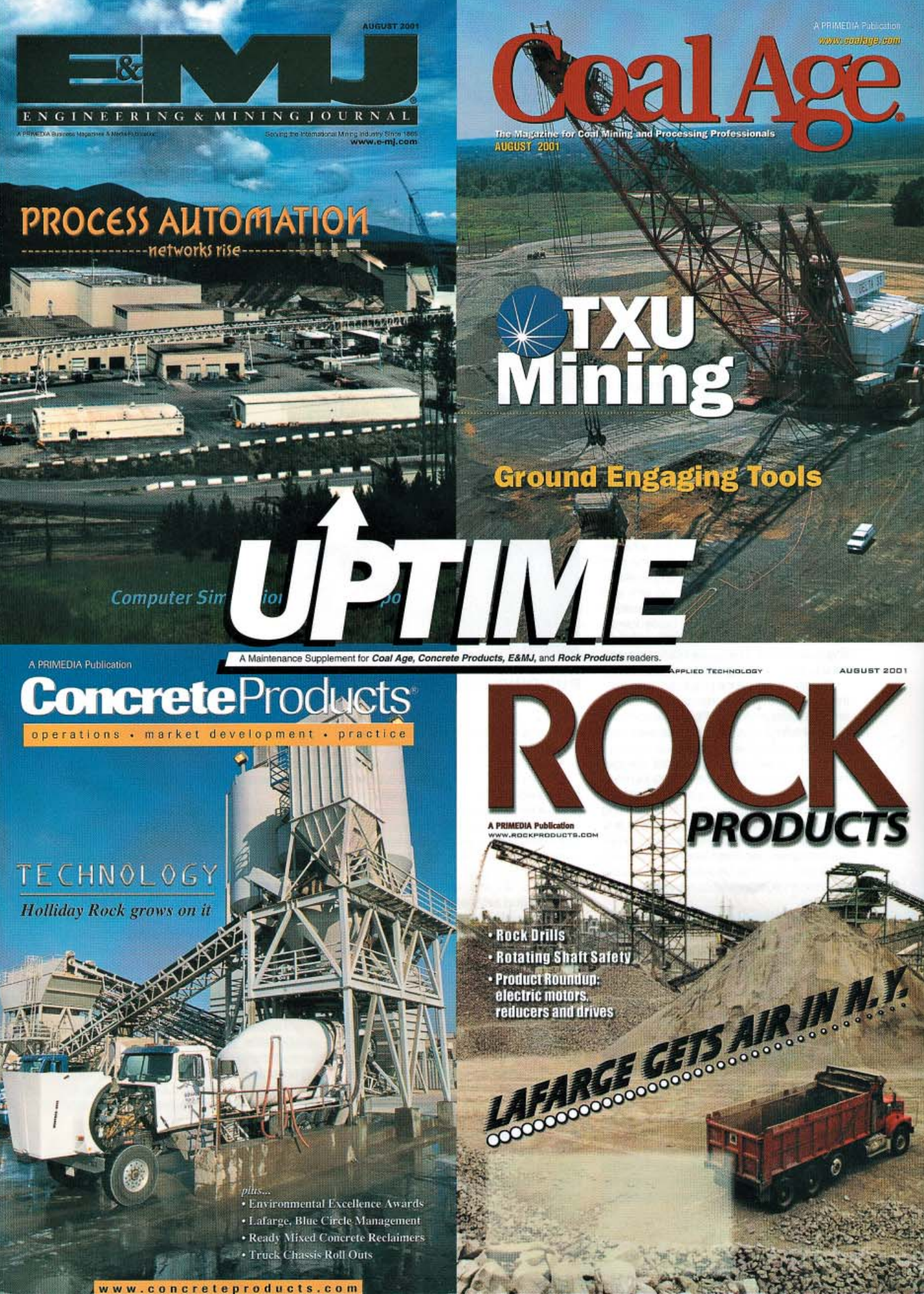
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Climbing the Ladder to World Class Maintenance Status

Quality maintenance programs keep operations running smoothly

World-class status is defined by Terry Wireman, author of *World Class Maintenance*, as "the ability to compete anywhere in the world, to be able to meet and beat any competitor anywhere in the world with product, price, quality, and on-time delivery."

A world-class maintenance operation differs from a run-of-the-mill operation only by the degree to which it achieves its primary function: to ensure that the right amount of equipment is ready and available without costing the operation an arm and a leg. An automobile runs most efficiently—with better gas mileage, fewer breakdowns, and a smoother ride—when it is well tuned and maintained. The same holds true with mining and quarrying equipment.

Quality maintenance practices keep mining and quarrying operations running smoothly and profitably. Poor practices can bring productivity to a halt and seriously affect the bottom line.

"As a general rule, I think most companies could do a much better job of measuring maintenance," said Dean Carrier, operations manager with USC Consulting Group. "A standard measurement in any operation is to look at the volume of product produced per direct labor hour utilized, but there seems to be a firm belief among maintenance organizations that this can't be done."

He says that maintenance staff frequently evaluate their productivity based on which specific employee does the work. This is a far cry from how the production side usually works, said Carrier. "Production people say it doesn't matter who mans the machine center and it doesn't matter who drives the truck. They still expect a specific amount of tonnage to move during a shift."

Maintenance organizations, on the other hand, tend to believe that a certain amount of work will get done by noon if the job is assigned to Joe Smith, but, if Bill Jones gets the assignment, the work won't be done until next Tuesday.

"Maintenance organizations tend to start off with metrics that lack detail," said Carrier. "They have few historical measurements, so they can't really focus on what needs to be improved."

BUILDING BEST PRACTICES

Carrier cites five key components for attaining world-class maintenance status as defined by Terry Wireman, author of *World Class Maintenance*:

- Quality equipment maintenance;
- A positive attitude toward preventive maintenance (PM);
- Labor planning;
- Inventory control; and
- Using automation in the field to optimize the maintenance department's ability to meet its goals.

Each of these areas must be tracked closely with clearly defined metrics that allow for quick problem spotting and even quicker resolution. That means looking at basics, like costs, availability, reliability, overall practices, and how personnel are used.

"Inventory and inventory dollars are critical here," said Carrier. "For example, it's extremely important to take a long hard look at critical spares and non-critical spares. What are we actually spending and buying? What's in the warehouse?

"Consumable supplies—any piece of equipment that ultimately gets thrown away, like tires, oil filters, or batteries—can eat up more money than you realize. At one mining location, tires for pickup trucks were running about $115 apiece and they were using about 200 tires a year," Carrier said. "After a few phone calls, we were able to locate a different supplier, about 100 miles away, who was willing to deliver the tires to the mining site for about $75 each. That meant a savings of $8,000 every year. Those seemingly 'little' numbers," he said, "add up pretty quickly."

Planning also plays a big role in world-class maintenance practices. Every operation has a master plan, but how effective is it?

"If you go into any operation and ask if they have a production plan or a capacity plan," said Dave Shouldice, USC senior operations manager, "the answer is always 'yes.' If you ask them if it's the right plan, they always say 'yes.'"

If that's the case, what's holding back some of North America's best mining and quarrying organizations from world-class status?

Carrier says that most are experiencing at least some of the same recurring problems, among them:

- Computerized maintenance management systems that do not deliver the expected benefits;
- Allowing production to constantly change daily maintenance plans;
- Lacking connection between production and maintenance resource capacity planning;
- Overrunning planned shutdown times;
- Mismanaging outside contractors;
- Overlooking work order disciplines;
- Poorly defined labor productivity; and
- Stagnant or increasing maintenance cost-per-ton.

"Maintenance organizations tend to start off with metrics that lack detail. They have few historical measurements, so they can't really focus on what needs to be improved."

These problems stem from a number of common mistakes that Carrier and his USC colleagues see on a fairly routine basis. In many cases, work orders are not estimated for labor hours, trade skill, and parts requirements. Often the orders are issued without the proper materials on hand. This slows maintenance to a crawl and creates a backlog of maintenance orders that can run more than six months behind. This situation causes a loss of faith in the system and results in the system not being used at all.

Maintenance shutdown plans are not made against a timeline, so that downtime is often far longer than anticipated. Even then, shutdown postmortems are rarely, if ever, conducted to determine the causes for the delays. Frequently, employees and supervisors are not trained to drive to the root cause of problems, so Band-Aid solutions become the accepted norm. This is the No. 1 source of friction between maintenance and operations.

Preventive maintenance (PM) routines are seldom reviewed, a practice USC recommends be done at least once a year. Records are not centralized or easily accessible, so that predictive maintenance practices are difficult to develop.

Carrier illustrates how much money can be saved through quality maintenance practices with this example. At one open pit coal mine, management wanted to increase throughput to meet demand. They believed this was the easiest way to reduce unit cost, particularly since the downstream capacity was available. They thought the best way to facilitate this plan was to purchase a number of 200-ton haul trucks at a significant capital investment. They didn't see any way to move more overburden or coal with their existing equipment. Every piece of equipment on site, with the exception of those in the pit maintenance shop, was operating 24 hours a day, seven days a week.

When USC was called in to assess the opportunities for increasing throughput, they started with the maintenance function and the availability of haul trucks. In their evaluation of the PM program, they learned that it typically took 30 hours from the time a truck showed up at the garage until the time it went back into service. Working with the employees and supervisors, USC used their Process Mapping expertise to determine the actual work content, as well as sources of delays and other non-value adding activities. Then an Employee Involvement Prototype was used to determine the best sequencing of activities and parts delivery to minimize the time required to put the equipment back into the pit. Standard procedures, metrics, and a problem identification and resolution process were developed and documented, resulting in a reduction of 10 hours in the time required to turn around a haul truck.

Unscheduled breakdowns were addressed next. An unscheduled breakdown is caused by one of two issues: fatigue (the part wore out) or stress (the part was improperly maintained or abused). Carrier says it normally takes 20% less time to do a repair job that is planned vs. completing an unplanned breakdown job.

While emergency repairs can probably never be eliminated, they can be minimized. The key is to create a method for analyzing what is failing, why it is failing, and how to avoid the failure. One way to accomplish this is to implement mean time between failure as a key metric in the maintenance operation. This requires a good equipment history documenting what was repaired and how long the part had been in operation before failure.

Using a Pareto chart as a tool, each type of equipment can be analyzed to determine which part is causing unscheduled repairs. Following up with a root cause analysis will help to determine if the operation should:

- Go to predictive maintenance (change out after a set number of hours of operation);
- Choose a different supplier for longer part life;
- Change the PM program; or
- In some cases, change such operating procedures as grading the haul roads more frequently.

In this particular case, USC was able to extend the amount of time the haul trucks could be used by about 10% before they experienced an unscheduled failure. Multiply that 10% by the number of trucks in the fleet and the savings are significant.

The upshot at this mining operation was that with improved equipment availability, there was no need to purchase more haul trucks to meet more aggressive throughput goals. From a capital expenditure perspective, the company saved hundreds of thousands of dollars. In addition, production and labor cost savings ran upwards of $2 million annually, year in and year out.

THE BIG PICTURE

"You can't look at the maintenance process in isolation and expect to attain world-class status," said Joe DiNapoli, USC senior operations manager. "You have to look at the grand scope and involve people from every part of the operation and at every level. There are certain things that need to be done and certain changes that need to take place within the production group or the operations group, for example, that can facilitate what's being done in maintenance," he said.

In an open pit, a truck can suffer a lot of abuse as a result of the quality of the roads they drive over. The roads are usually maintained by the operating group and are far from highway driving quality. They are bumpy and rough.

The wear and tear on the trucks can be devastating to production. Just re-grading the road beds on a regular basis can extend truck life enormously and it goes a long way toward reducing the amount of time trucks spend in maintenance.

Dave Shouldice cites another example. "A zinc ore mine in the Yukon was having big problems with maintenance. We spent a lot of time getting detailed input from the maintenance group and comparing it with the master mine plan. It soon became obvious that they didn't have the right mix of equipment. They were over-shoveled and over-trucked. And they were short on D10Ns with ripper blades and graders, both of which support the shovels."

By taking the maintenance group's information, which detailed recurring problems with the hard toes on shovels that were constantly hitting benches, and unusually frequent breakdowns on drills, haul trucks, and banjos, it became evident that the blasting pattern was creating the worst maintenance issues.

"Multiple small blasts were being done. This pushed them into a vicious cycle of repeated equipment pullbacks that were putting a lot more mileage and stress on this massive equipment than normal. The result was continual production slowdown and horrendous maintenance costs," said Shouldice.

By bringing together the different operational and maintenance elements and analyzing the information to determine the root

KEY OPERATING METRICS FOR MAINTENANCE

Create metrics for work control and improvement.

Look at labor productivity by comparing estimated to actual man-hours.

Compare the percentage of man-hours spent on emergency vs. scheduled maintenance.

Stick to a weekly plan that includes a schedule for breakdowns.

Analyze the mean time between failure to determine cause, evaluate program effectiveness, and develop a predictive schedule.

Track the mean time required to make a repair.

Record the mean time required for responding to a work order.

Examine inventory turns to evaluate the effectiveness of invested working capital.

Keep track of backlog and age of work orders by trade and weeks of work.

Sustain the effort for continuous improvement.

causes for the problems, USC was able to develop a new capacity plan. It gave the mine the right mix of equipment to support the operation and a better schedule for larger blasting sizes and patterns to reduce excessive equipment movement. It was a big step toward world-class maintenance practices for this mine.

SIX STEPS TO CLIMB THE WORLD-CLASS LADDER

Determine Where You Stand Today

1 The first rung on the ladder to world-class status requires mining companies to determine where they stand against world-class maintenance principles. This entails three simultaneous actions. The first is to perform an in-depth survey in all key areas, including:

- Maintenance organization;
- Training programs;
- Work order system;
- Planning and scheduling;
- Preventive maintenance;
- Inventory and purchasing;
- Reporting; and
- Automation.

In the second action, develop a pictorial overview of the current flow of maintenance information. This requires involving every employee in a review of his or her role in the maintenance process and putting every activity into a schematic diagram. Focus on "the life cycle of a work order" and what metrics are currently used to determine the effectiveness of the department and the interactions with other departments.

Finally, do a series of task observations to learn what actually impedes the ability of the maintenance people to accomplish their daily assignments. Spend full shifts with the tradesperson to see the operation from their eyes. Document and graph the percentages of their day spent adding value, performing non-value added tasks or idly waiting for something to happen. "It is not unusual to find that value-added time is well below 50% of a tradesman's day."

"This first step is one of the toughest for any manager," said Carrier. "Each and every day he says he's going to go in and make a difference. Then the realities of the day strike him in the face and he never has time to come up for air, let alone tackle some of those big issues that are so important. This is why companies like USC can help jump-start the process. We have the tools and the knowledge to come into any mining or quarrying situation and get the ball rolling."

Create a Vision for the Future

2 The second step calls for a company to create a vision for the future. By using the results from the first series of assessments, a vision that speaks to both maintenance and production can be designed and communicated throughout the operation. The vision doesn't have to be detailed; let the people fill in the blanks. But it must show a firm commitment on the part of the site's senior management team to do things differently to make the operation more effective.

"You simply cannot build a world-class maintenance operation in isolation," said DiNapoli. "It requires the active involvement and support of every other group on the site and it requires a serious commitment from top management."

Involve Employees in the Change Process Through Prototyping

3 This is where the catalysts for success are generated: Develop a system through employee involvement. "Pulling in every employee and involving each one in developing a better system is the key to world-class success," DiNapoli said.

Carrier said, "There's always some resistance to this approach. Many employees will say, 'Heard it all before.' But once they are presented with hard facts and a new system that they've helped devise to make their lives easier and their work better, they accept the validity of the approach."

Use an Employee Involvement Prototyping process to engineer change and achieve buy-in. Do this by choosing one shutdown, one work group, or one tradesperson to develop and prototype methods of planning and scheduling, controlling, reporting, and improving the operation to meet the challenges laid out in step two. The key to success here is a daily review meeting, attended and chaired by the senior management team. Their role is to demonstrate solid support during the transition process and to answer five basic questions at every review meeting:

What did you like and dislike?
What do you want to change?
Who will be responsible for making the change happen?
When will it be done?
What did you learn?

Roll out Successes Across the Organization

4 Roll out the new changes across the entire organization. This can be done effectively by promoting the success of the prototype. Also, by developing a complete management system around the prototype, buy-in is more quickly achieved.

Avoid the temptation to try and implement the changes across each work group (foreman and his crew) simultaneously. This is difficult to control and can put the success of the change process at risk.

A supervisor and his crew are a natural grouping for implementation. Roll out the changes starting with the work groups most open to change and proceed to those most resistant, and use the lessons learned from each previous implementation. This will help the employees identify with the value of the changes.

Don't be shocked if early in the establishment of the new systems maintenance costs increase. This is only a temporary state that shows up because more materials are being consumed. It will right itself as the practices come into balance and the processes are streamlined.

And find a reason to celebrate each successful installation. This further fosters employee buy-in and their long-term commitment to the changes.

"It is not unusual to find that value-added time is well below 50% of a tradesman's day."

Avoid Backsliding Through Quarterly Systems Audits

5 Once these changes have been implemented, they must be maintained through a continuous commitment to the rigors of the new system. That means keeping the same discipline and focus that was used when designing the new systems. The natural human tendency is toward slippage, so it is very important to avoid complacency.

Use an audit to measure compliance and identify backsliding. World-class performance is a never-ending journey and it's easy to lose the way when you stop paying attention to the system. To stay on the path, develop a system audit and use it on a quarterly basis. The audit is crucial in determining the level of adherence to the system rigors and to alert management if further changes are required as a result of changes to the process. USC recommends the system pieces and disciplines be incorporated into existing quality management systems like ISO certification.

Automate the System

6 Automate, automate, automate, but don't expect automation to lead to improvement by itself.

"The difficulty in starting with automation," Carrier said, "is that it doesn't fundamentally change anything that is already being done, so, ultimately, you'll get the same results a lot faster. Labor productivity won't change just because work orders are in a database vs. in a filing cabinet. Inventory turns won't increase—or stock-outs decrease—unless the procedures and rules for purchasing and inventory control are changed."

In one open pit coal mining operation, an automated maintenance system was put in place in the hope that it would improve the maintenance department's productivity by 20% or 30%.

When USC came on to the scene a year later, they compared the current maintenance performance characteristics to where the operation had been a year before. They looked at such items as the mean time between failure, labor productivity (actual hours worked vs. estimated hours on the work orders), and meeting maintenance schedules. None of the numbers had changed with the introduction of automation. The operation now had lots of reports available for analysis, but management either didn't believe the numbers they produced or the reports were not particularly user friendly.

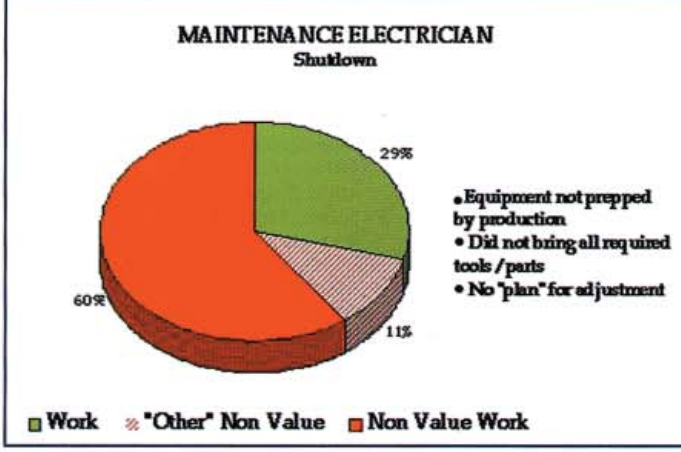
After talking with a number of mechanical and electrical people in the shops, USC learned that everyone knew what was available from the warehouse, but nothing in the system had changed to help get the parts from the warehouse to where they were needed.

"Basically, nothing had been done to change the culture of the operation from a reactive emergency fire fighting organization to a preventive or predictive one," said Carrier. "Without careful analysis of the various activities required to complete a maintenance task, identifying causes of failures or making adjustments to routing, automation brought nothing to the party."

The key to making automation really work is to change the process and the culture first, then automate it to make the process easier to manage. Take the time to look for the best fit, an automated system that works miracles in one situation may not necessarily be the best solution for another.

This article was provided courtesy of USC Consulting Group. Since 1968, USC has counseled companies on maintenance issues by focusing on the management of the process rather than the technical orientation.

When You're Not World Class



Joe DiNapoli is vice president, senior operations manager at USC Consulting Group. Dave Shouldice has been with USC since 1986 and is a vice president, senior operations manager. Dean Carrier is currently operations manager with USC Consulting Group (905/673-2600).

"...Band-Aid solutions become the accepted norm. This is the No. 1 source of friction between maintenance and operations."

RANK YOUR COMPANY AGAINST WORLD-CLASS PRACTICES

1. Plan for preventive and predictive maintenance. Sometimes predicting when parts will need replacing is more cost effective than continually trying to keep them going through preventive maintenance practices.

2. Define the mean time between failures and mean repair time. Time is money, as always, and this will give you back some of each.

3. Focus on task, labor, and material planning. Make certain that the task has been assigned to the right person with the right skills, that the person is available to perform the task and that the required materials are on hand when they are needed. This reduces wait around time.

4. Maintain work coordination and control. Keep the process moving by defining all the tasks and assignments and keeping an eye on the time and costs involved to ensure quality project completion.

5. Identify problems for quick resolution. Recognizing the problem is the biggest step toward a solution. Focus on the biggest cost issue and resolve it before moving on.

6. Continue to improve every step of every process every day. Review records frequently to determine whether processes are slipping on costs, labor time, or quality.

7. Record information on such items as time, cost, labor hours, availability of parts, and skill requirements.

You can rank your mining or quarrying operation against world-class practices and your competition by contacting USC for its world-class comparative diagnostic audit. It's available, free of charge, on computer disc in Excel format. Simply answer the questions and return the disc to USC to receive a report showing how your company ranks. All information provided will be kept confidential. To receive an audit, contact USC Executive Vice President Jack Korpela at 905/673-2600 or by E-mail at jkorpela@usccg.com.

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