TMG News

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"Sharing Information to Improve Reliability"

Benefits of Planned Domain

We have spent considerable time in the newsletter focusing on the benefits and execution of the precision domain – removing the defects at the source. Our philosophy has evolved based on working with clients and modeling reliability; most organizations would be advised to focus first on eliminating defects and then on making the defect removal process more efficient with a planning and scheduling process. However, there are significant benefits to the Planned Domain and this article focuses on the specific benefits that are generated through the Planned domain and the keys to a successful transition to the planned domain. Using our Dynamic Benchmarking model and data from a hypothetical chemical plant we modeled at DuPont, we were able to calculate the benefits.

The Model

The model represents a chemical plant that has a replacement value of $444 millions. The plant employs 91 mechanics who complete approximately 500 work orders per week. The plant operates at an average of 83.5% of full capacity but could sell more product if the plant ran better.

The model was built during a one year process and contains dynamic relationships that characterize the maintenance operation. The data for the model was drawn from internal DuPont reports, benchmarking studies, maintenance literature, interviews, and managerial judgment.

The model is organized around the flow of equipment. The equipment can flow from a state of full functionality into either the Breakdown or Planned maintenance process. Equipment enters the Breakdown maintenance process when it breaks down and remains there until it is repaired. Breakdowns are caused by equipment defects that are introduced by the operation of the equipment, poor materials, poor design, or poor workmanship. The time to repair the broken equipment depends on the number of mechanics allocated to Breakdown maintenance and the productivity of the mechanics in executing repairs. Equipment moves into the Planned maintenance process when an inspection identifies a defect in the equipment. Some of the equipment inspections are required by law and are mandatory. Other inspections, typically those involved in a predictive maintenance program, are discretionary in the sense that maintenance managers determine their frequency. The inspections are valuable because they identify problems before the equipment suffers a costly breakdown. Scheduling involves setting a time when the equipment can be disconnected from the manufacturing process flow so that it can be worked on. A poor Scheduling process can cause a disconnect between inspections and repairs. Once it is taken off-line, the defective equipment can be repaired. The time to complete Planned maintenance depends on the number of mechanics allocated to Planned maintenance and the productivity

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Premature Failures Eliminated

At a Manufacturing Game® workshop at Michelin in New Glasgow on February 28, 2003, an action team was created to address the problem of premature failure of drum inflation membranes that were causing a loss of production and excessive membrane costs. This problem had been going on for quite a while but no one had paid much attention to it. There was a general consensus that no one would resolve the problem.

Although the situation was not fully understood by the team members, Mark MacKinnon, Mike Vienneau and Martin Cummings had discussions at the TMG workshop and determined that an investigation was in order. During this investigation, Mark MacKinnon, an Operator, was rummaging through failed and cut membranes and found repeat failures at the inflation groove close to the air inlet. The big question the group had to ask themselves was "Why were the membranes consistently failing around the inlet port?" The root cause analysis forced the team to investigate all of the possible causes for the failure and one of the possibilities was a defective vendor product.

Mike Venotte, the Maintainer, contacted the supplier to discuss the failures and the Reliability Responsible investigated the installation procedure. Remarkably, two causes were discovered. Mark found that the inflation pressure being used was two times the recommended operating pressure and further discussions with the supplier revealed that there was also a design flaw in the rubber consistency around the inlet.

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of the mechanics in completing the repair. Planning is one of the factors that effects the efficiency of the mechanics in completing Planned or Breakdown maintenance. Planning refers to the process of creating an explicit plan for doing a specific task, planning increases mechanic productivity by standardizing work practices and by making sure that the materials and necessary skills are available to finish the job. In the base case simulation, the plant does mostly Breakdown maintenance. There is almost no manpower allocated to doing discretionary inspections or to creating job plans, the maintenance strategy can be described as reactive in the sense that the maintenance organization reacts to breakdowns instead of preventing them.

Results of the Modeling

In this section, three of the maintenance programs are implemented in the simulation model. The results of the simulations are compared to the reactive maintenance strategy that is used in the base case simulation. Although the model generates a variety of performance measures, for simplicity, the simulations will be compared on the basis of plant uptime. Using other measures, such as net present value or cost to compare the simulations does not change the basic results.

1. Planning

The first simulation implements more extensive job planning. This policy is implemented by increasing the number of job planners by reallocating seven mechanics to planning and by adding a library of plans. The library increases the productivity of the job planners by making it unnecessary to create a new plan for every job.

The rationale for increased planning is straight forward. More planning increases mechanic productivity. Higher productivity reduces the time to repair equipment and increases equipment uptime.

Just as it was in maintenance at the plant sites, the result of adding planning in the model is disappointing. Uptime increases by only 0.5%, which would not be measurable in the plants.

There are two reasons why the planning program is unsuccessful. First, in the reactive case, most of the work is breakdown work. By definition, breakdown work is difficult to plan and adding planning has a small impact on the efficiency of doing Breakdown work. Turning mechanics into planners is wasteful if the plans don't add much to productivity. Second, with a reactive strategy, the plants are typically overstaffed and there is not enough work to do on a day to day basis. Improving efficiency in their work causes mechanics to complete work faster when work is available but also lengthens the gaps when there is no work available. The net effect is a very small increase in mechanic productivity and uptime.

2. Scheduling

The second simulation implements a more efficient scheduling system. The first element of the scheduling program is to shorten the delay between the time a defective equipment piece is identified and the time it can be worked on. The second element of the program is to improve the scheduling system's memory. When a piece of defective equipment is identified, often no action will be taken on it immediately because operations needs the equipment on-line. In this situation, the scheduling system may not remember that the equipment was defective unless there is an explicit record keeping system. The second element of the policy implements an efficient record keeping system.

The rationale for the scheduling policy is straight-forward. Better scheduling should increase the efficiency of Planned maintenance and lead to fewer breakdowns. Fewer breakdowns increases uptime. However, the results of the scheduling policy are disappointing. Up time increases by only 0.8%, which would be imperceptible at the plant.

The scheduling program fails because, in the base case, the plant is doing very little Planned maintenance. Breakdown maintenance, which is most of the work in the base case, is by definition unpredictable and almost impossible to schedule. The scheduling policy does very little to improve the efficiency of Breakdown work.

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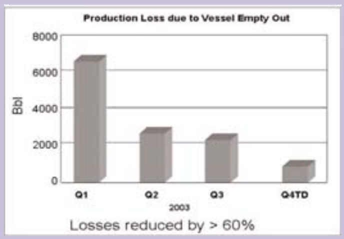
Elimination of Vessel Draining During Jet Pump Tripping

At an Operations Excellence Game workshop at BP Pakistan, an Action Team addressed the problems with the tripping of jet pumps resulting in the complete draining of vessels. This defect required the refilling of vessels to bring the jet pumps back into operation. These recurring failures were causing significant production losses that were even higher for the jet pumps being tripped during the night shift. Night driving in the field is not allowed in BP Pakistan operations and these night-time driving constraints made it necessary to wait until daylight to refill the vessel and put the pump back in to operation resulting in even greater losses.

The team investigated the possible causes of these recurring trips by using an e-choke tool. They determined that the actual cause of failure was not known but discovered three potential solutions assigning a priority to each solution. 1.) Leakages on the surface



from jet pump vessels or associated piping. 2.) Vessel liquid going into the tubing, and 3.) Vessel liquid going into the flow line.

The team proposed remedial measures. The Instrumentation & Electrical section of the Maintenance Department in collaboration with the production team carried out modifications through MOC (Management of Change) procedures to interlink the jet pump engine low oil pressure security with the logic of ESV's (Emergency Shut down valves) installed on the casing return line and flow line. This modification was applied to more than 30 jet pumps based on production and tripping frequency. These modifications ensured actuation of ESV's on jet pump tripping and eliminated emptying out of the vessels.

While experiencing improved operating efficiency, savings in maintenance man-hours, and success in achieving 60% overall reduction in production losses, the team is now devoting time to investigating the root cause.

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3. Predictive & Preventive Maintenance

In this policy, the frequency of equipment inspections is increased, in the base case, the frequency of inspections was one every twenty weeks on average. In the predictive and preventive program, the frequency is increased to one every two weeks. More inspections should identify equipment defects before they cause failures, fewer failures should directly increase uptime.

The predictive and preventive program is counterproductive as uptime falls by 2.4%. This surprising result is caused by the interaction of several factors. First, increased inspections draw manpower away from repair work. This would be fine if the inspections resulted in repairs that prevented breakdowns. Unfortunately, many of the inspections find defects but, without an efficient scheduling system, the inspections do not result in equipment repairs and the equipment fails while it is waiting to be scheduled. The man-hours spent on inspections are wasted for the lack of a good scheduling system. Second, some of the inspections do result in repairs but without a planning system, the repairs are done inefficiently. This increases the time to repair which decreases uptime.

4. Synergy between Policies

The analysis presented above suggests that there should be strong synergy between the maintenance policies. Model simulations reveal this to be the case. The combination of planning, scheduling, and predictive and preventive improves uptime by 4.1%. The combination of these three policies with an improved maintenance materials supply process increases uptime by 5.1%. Clearly, it is the combination of the four policies that generate the gains that were expected from a Planned maintenance process.

Overall, the analysis of the model can be distilled down to two basic conclusions. First, a structural analysis of the maintenance system demonstrates that it is unlikely that maintenance programs will be successful if they are implemented separately. Second, there is a great deal of synergy between the policies. The combination of planning, scheduling, predictive and preventive maintenance yield the expected benefits of the Planned Maintenance approach while the individual components, taken individually, produce small benefits in the long term.

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After consulting with the Quality and Uniformity group, the crew reduced the pressure back to normal. The group was originally responsible for the increase. They also followed up with the supplier to ensure that progress was being made on eliminating the design defect in a timely manner.

The action team truly performed as a team. The pressure limit control was handed to the Dimension Change group who is responsible for the initial setup of the machine when a new tire line has to be built. Although it took somewhat longer to have the supplier eliminate the design defect, immediate benefits were experienced. The membranes previously had been failing once a week resulting in one hour of downtime. After reducing the pressure, the failures reduced to once every five weeks, which is the appropriate life of the membrane. This was a huge gain in throughput. There was also substantial savings in the reduced consumption of membranes.

It's amazing how a thorough root cause analysis by a team truly working together can eliminate a simple but very costly problem.

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Action Team Exhibits Fierce Determination in Eliminating Equipment Bug

At an Operations Excellence Game workshop held at BP in Trinidad recently, an action team proved fierce determination, dedication, and curiosity can get to the root cause of a baffling equipment problem. The team was inspired by the slogan "don't just fix it, improve it" and when faced with an unexplained problem with a new solar turbine, they went into action.

The turbine, designed to run on both liquid and gas fuels, was shipped to Trinidad after it was successfully tested on both fuels in San Diego, California. Once in Trinidad, the turbine did not work when local liquid fuel was used. The initial assumption was that there was a problem with the quality of the local liquid fuel. The team began work trying to resolve the problem by first, sending off a sample of the fuel for testing. While waiting for the results from the test, the team contacted the vendor to arrange for some training on the operation of the turbine. They felt training would help them to better understand the equipment. The vendor conducted two five-day training sessions. The sessions sparked the interest of the team members and they became extremely curious as to why the turbine would not work with the local fuel. They continued researching the turbine and went over the design drawings with a fine toothcomb. They were frustrated when they were still unable to determine the cause of the problem but the team pressed on. With the help of the vendor, they took a closer look at the turbine itself. When looking at the fuel diverter valve, they noticed some grit and foreign matter in it, which they determined might have occurred during shipping from San Diego. The valve then became the focus as a potential source of the problem.

The team then delved further in to researching the valve with the help of the vendor. They then discovered that the valve had been recalled. The vendor immediately replaced the recalled valve and lo and behold, the turbine worked, using the local liquid fuel.

The action team was thrilled to ultimately conclude that the root cause of the problem was not the fuel quality at all. This inspired a new team mantra "Trini Fuel Good". The team's fierce determination and "never say die" attitude demonstrated a best practice of getting to the source of a problem instead of just patching up a symptom. The team credits their success in completing this action team to their curiosity, which was inspired by the training they received in defect elimination. They feel that their commitment to resolve the problem led to a deepened commitment to resolving a problem that they will carry over into future action teams.

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