

This article presents an effective approach of using cross-functional teams to identify and reduce recurring failures through a systematic approach called Total Process Reliability (ToPR) netting a 90% costs savings for the plant.

Applying a Synergetic Approach to Improve Equipment Uptime

by Kevin Pait and Preston Ingalls

The Company

Grifols Therapeutics Inc (formerly known as Talecris Biotherapeutics, Inc.) is a wholly-owned subsidiary of Grifols Inc, a subsidiary of Grifols S.A., a Spanish company based in Barcelona, Spain. Grifols S.A. is a global healthcare company and leading producer of life-saving plasma protein therapies. Grifols Therapeutics manufacturing facility is located in Clayton, North Carolina. This is a case study of a reliability improvement process put into effect at the Clayton facility with a focus on the centrifuges used in Grifols' fractionation process.

Addressing Maintenance Costs: Initial Steps

In late 2006, driven by the need to reduce high maintenance costs and increase machinery uptime, senior management at the Clayton plant decided to implement Total Process Reliability (ToPR). ToPR is a reliability process centered on proactive maintenance rather than reactive maintenance with the goal of reducing operating costs and increasing productivity of machines.

The success of ToPR, pronounced "topper" by the Clayton team, is dependent on the commitment of senior management, and so the initial ToPR program implementation began with the education of those key individuals. In addition to providing ToPR training, primary steps included baseline studies, which provided solid evidence for improvement opportunities. In order to attack high maintenance costs, Grifols also needed to identify critical equipment and problems associated with critical equipment. Through this critical equipment analysis, the centrifuges were identified as the highest cost area in the plant, averaging more than one million dollars a year for repair and

maintenance. The centrifuges separate plasma into fractions that are then used in a variety of biotherapeutic products, and therefore, the equipment failure poses a threat to production rates.

Equipment Improvement Teams and M.O.R.E.

Once the centrifuges were identified as critical equipment, Grifols could develop a ToPR plan focused on improvement. According to Kevin Pait, Director of Plant Engineering and Maintenance, "we started out forming cross functional teams," referred to in the ToPR program as Equipment Improvement Teams (EITs). Composed of employees from maintenance, engineering, and production, the EITs took a centrifuge apart and then put it back together with the goal of fully understanding the machine's assembly and functionality. Senior Manufacturing Supervisor of Fractionation, Joey Hamer, said this step "taught his crew how the machine ran from top to bottom." While the initial EIT effort was important because, according to Pait, "it helped employees appreciate each other's roles and responsibilities at work," Grifols did not see desired results with the EIT approach. After rethinking their approach, management decided to form another team that would still be cross functional, but with a stronger technical base. "We had different groups all working independently trying to make a difference," said Kirk Parish, Manager of Maintenance Systems. "All these efforts existed as silos. We put all these silos together." The new team was named after the different departments represented: Maintenance, Operations, Reliability, and Engineering (M.O.R.E). The M.O.R.E. team discussed current challenges and brought forth improvement methodologies in hopes of

achieving the team's goal to cut 20% from the previous year's maintenance cost.

Identifying Root Causes

The M.O.R.E. team acknowledged that some critical variables in the machines were not known or understood, which made it difficult to identify true causes of maintenance and operation problems. Ingrained individual opinions about what leads to a centrifuge failure and a lack of data to support assertions further complicated the problem. Mike Cook, Manager of Maintenance and Reliability, said the predicament "just went around in a circle." Grifols needed to identify the root causes of failures and quantify these causes with engineering studies.

In order to objectively identify the sources of centrifuge breakdown, employees developed a cause map, which is a root cause analysis tool that starts with an event and works backward to uncover the causes of that event. "This makes you think sequentially," explained Pait, and allows for the removal of opinion through testing for true root causes. Each possible cause of failure was tested, enabling true causes to be validated with plant studies, extensive experiments, and vibration analysis. According to Hamer, vibration was the issue leading to breakdown, and so, using precision lasers, the Grifols team established a baseline vibration measurement of when the machines were functioning correctly. During the vibration analysis, the team also induced a variety of problems identified by the cause map. This allowed for vibration measurement, providing empirical proof of what led to failure. Internal bowl vibration creates additional bushing wear, spindle wear, and ultimately leads to failure as illustrated in Figure 1.

During the ToPR efforts, the team also utilized the Pareto Principle, which states, simply, that most problems are caused by a few key factors. According to this principle, if Grifols could identify these few key problem-causing factors, they should be able to eliminate (or at least drastically reduce) the rate of centrifuge failure. With this in mind, the ToPR team lined up all the factors that contributed to failure in order to identify items of "high probability and high consequence."

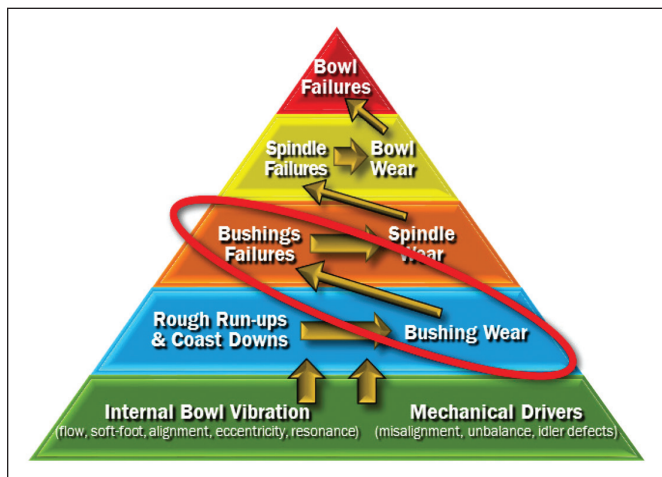


Figure 1. Failure mode progression.

One problem of "high probability and high consequence" identified by the Pareto analysis pertained to the clearance between a centrifuge's boss and bushing. As parts wear down, this clearance becomes larger and the vibrations of the machine increase. "If you get off center at the bottom," Hamer explained, "it translates into a lot of whip up top and will cause the spindle to break, leading to a dramatic crash."

“ We had different groups all working independently trying to make a difference... ”

Another high risk item for the centrifuges is an improper soft foot, which often results from multiple failures that shake the machines' bases. Soft foot is a condition whereby inadequate surface contact is made between the underside of the centrifuge housing support legs and the foundation baseplate. Soft foot that is off by even a fraction of an inch can increase vibration, leading to machine failure. Correcting this high risk issue through precision maintenance was important to decreasing the number of centrifuge failures. As shown in Figure 2, the majority of the problems were due to bushing wear and soft foot.

One of the main parts of a centrifuge is the bowl where the plasma products collect during fractionation. High costs for bowl repairs contributed to the high cost of maintaining the centrifuges. In response to this issue, the maintenance department initiated an in-house bowl repair program. Prior to this initiative, bowls were always sent to the supplier for repair, but the maintenance department realized many of the bowls could be repaired at the Clayton facility. The team also discovered the bowls have a tolerance range, and as long as

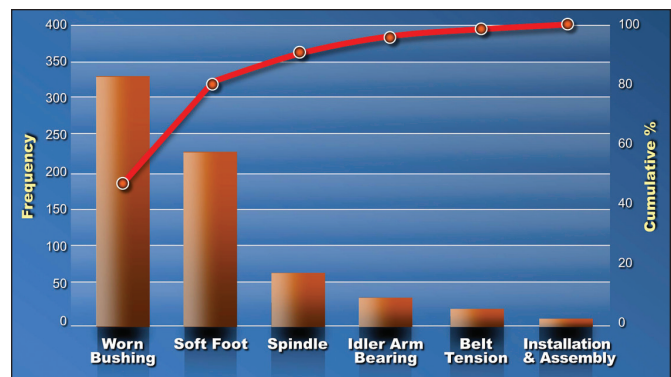


Figure 2. Pareto analysis.

the bowls fell within this tolerance range, the machines could still function. Only when the bowls exceeded this tolerance range, did they need to be completely replaced.

The cause map and Pareto analysis also identified the centrifuge's idler arm as an item of high consequence whose malfunction can lead to failure. The idler arm is a tensioning device that applies force to the belt section running from the centrifuge to the motor. This helps to ensure the centrifuge runs smoothly without belt slippage when rotating. According to Cook, if the idler has a bearing defect or if the bearing becomes egg-shaped, that is a problem starter. The centrifuge bowl then begins to shake, putting excess stress on the spindle, eventually leading to failure.

“...builds a bridge with maintenance, operations, and engineering.”

Proactive Solutions

By isolating a list of high risk occurrences that result in centrifuge breakdown, and focusing on these problems, rather than low risk issues, Grifols was able to come up with proactive solutions. A key ingredient to the ToPR program is predictive and preventative maintenance rather than reactive maintenance. The goal is to find a problem before it's too late. With this in mind, Grifols implemented the use of a go/no go gauge on the centrifuges in order to address the bushing clearance issue. Using the go/no go gauge, operators can measure the wear on the inner diameter of the bushing. When the gauge sinks too far into the bushing, it is time for the bushing to be replaced. By replacing the bushing before the clearance between the boss and the bushing becomes too high, Grifols greatly decreased the failure rates. Another predictive maintenance initiative focuses on the idler arms. With routine checks of the idler arms' tension, more failures

were prevented. As mentioned above in regard to the bowl repairs, the Grifols team also created “documented tolerances.” A part that drops below its documented tolerance is likely to start a problem, so the goal is to remove any parts before they drop below these measurements. In addition to the in-house bowl refurbishment program, maintenance also developed a Centrifuge Failure Tracking Book. Maintenance uses this manual tracking method in conjunction with computerized maintenance management software to trend repeat failures. The identification of failure trends helped to greatly lower failure reoccurrences. With fewer multiple failures and the use of predictive maintenance, the issue of improper soft foot dramatically decreased as well.

In order for ToPR to succeed, team members need to put forth a consistent effort toward the end goal. To establish a consistency in maintenance, Grifols developed best practices for centrifuge assembly and disassembly as well as job aids. Job aids are uniform checklists that ensure everyone is maintaining the centrifuges in the same way. Pait refers to these job aids as “enabling tools for employees” because with the job aids, as Pait explains, “you are setting people up for success.”

Two additional solutions that resulted from the ToPR effort were the introduction of a spindle nut torque wrench and a Centrifuge Process Manual. Of the centrifuges, Hamer says, “We had some improper couplings and un-couplings. We needed a torque value to make sure the coupling is done correctly.” The introduction of the torque wrench eliminated potential for operator-induced failures. The Centrifuge Process Manual was created by a ToPR focus group to help employees learn, in depth, about the centrifuges. An instructor's version of the manual allows trainers to guide employees through the learning process. Employee technical training is a key element in the ToPR program.

Through use of the ToPR program, the cross-departmental team was able to systematically identify the root cause of each failure. These failures were mitigated with enhancement of the technical training program, implementation of various operational and maintenance tasks, and implementation of additional preventative maintenance tasks. The ToPR program results are summarized in Table A.

Conclusion

The final results of the Grifols' ToPR journey can be declared a great success. Financially, as illustrated in Figure 3, the company saw a 90% reduction in centrifuge maintenance costs, thus diminishing what had been the highest maintenance cost in the Clayton facility. By proactively managing high risk issues, the team increased machine uptime, thereby increasing plant productivity. And finally, the ToPR efforts led to a development of partnerships across plant departments. As a major driving force behind ToPR, Hamer said the effort “builds a bridge with maintenance, operations, and engineering.”

Kevin Pait summarized the accomplishments. “We have come a long way over the last four years in increasing reliability and we are moving from good to great. We were able to solve a rather multifaceted and complex issue. By applying

Symptom	Root Cause	Solution	Cost Reduction
Excessive Vibration and Spindle Wear	Worn Bushing	Operations PM	81%
	Soft foot	Maintenance PM	
	Idler Arm Bearing	Maintenance PM	
Vibration	Belt Tension	Maintenance PM	5%
Premature Bushing Failures	Installation and Assembly	Employee Technical Training and Job Aids	4%

Table A. ToPR program results.



Figure 3. Historical maintenance costs.

the focused team approach of total process reliability, issues that have plagued this equipment for years were resolved. Simply put, if two heads are better than one, we proved more is better than two.”

About the Authors



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